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L.S.

A FIRE HAZARD EVALUATION SYSTEM : PROPOSED DESIGN AND DEMONSTRATION

GRADIENT MODELING, INC.

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A FIRE HAZARD EVALUATION SYSTEM :

PROPOSED DESIGN AND DEMONSTRATION

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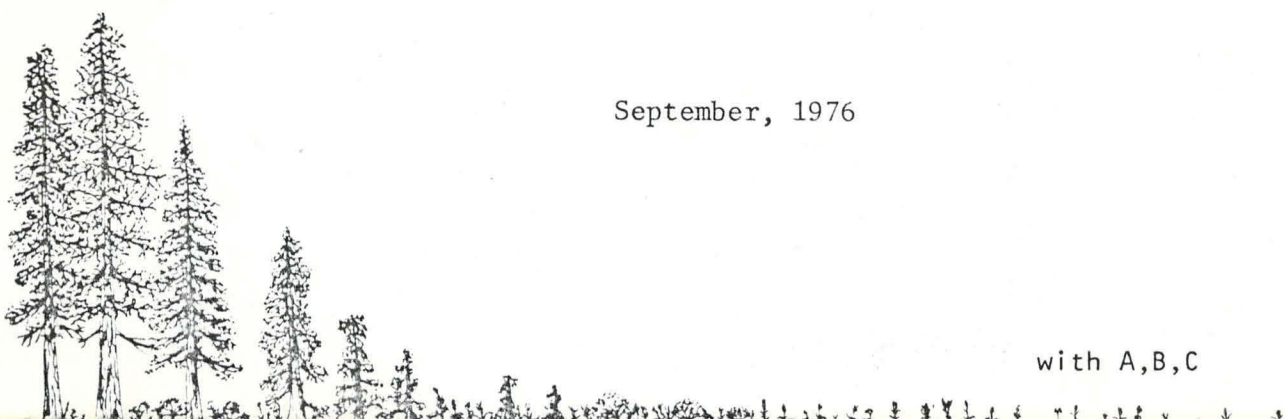

with A,B,C

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INTRODUCTION AND OBJECTIVES

With recent advances in the fire sciences, it is possible to develop a meaningful fire hazard evaluation system for application at the forest and district levels. Such a system involves the synthesis of several independently-developed techniques and models into a functioning unit which interprets hazard by examining its possible consequences, namely, the potential behavior of fire within the fuel complex. This system could prove valuable not only in its evaluation of current hazard, but also in determining future hazard due to natural fuels accumulation, preharvest and harvest treatment, or insect attack and blowdown, the degree of hazard reduction necessary to achieve a well-defined level of hazard acceptability, and the effects of weather on hazard and its potential consequences.

It is the objective of this study to develop and demonstrate such a procedure for evaluating and interpreting the fire hazard presented by a fuel complex.

HAZARD EVALUATION SYSTEM CONCEPTS

The hazard evaluation system proposed in this paper is based upon the tenant that fire hazard should be interpreted not in terms of the fuel array characteristics *per se*, but in terms of the fire behavior potential presented by that array under a distribution of expected fire weather conditions. While knowledge of the fuel loads and arrangements alone is useful information, it does not provide the answers to questions such as:

What constitutes an acceptable, vs. an unacceptable, hazard?

What is the hazard presented by 24 tons per hectare of fuel? Is it twice the hazard presented by 12 T/ha?

How much fuel treatment is necessary to achieve an acceptable hazard level?

How does the hazard vary with changing weather conditions?

It would also be desirable to introduce into any such hazard evaluation process the element of risk. Unfortunately, this factor is not yet quantitatively well-defined, and is itself difficult to assess. It may be easily introduced and used in any existing hazard evaluation system in the future, but will not be considered further in this study.

The hazard evaluation system presented here was conceived as possessing the following properties:

1. It should allow the user to select those fire behavior characteristics of greatest importance to him with which to evaluate his fire hazard. These may include the rate of fire spread, flame length, total fireline intensity, scorch height, and ignition temperature height. While some of the necessary behavior prediction models are not well tested at this time, they will still be included in the system in expectation of being more accurately defined in the future.
2. It should allow the user to define his own level of acceptable hazard (i.e., fire behavior). For example, a timber manager may have a scorch height acceptance level of 2.0 m for a lodgepole pine stand, but of 10 m for a Douglas-fire type.
3. The system should allow the user to define an 'exposure' threshold; the number of days during the season the hazard exceeds the acceptance level. This analysis is based upon an appropriate AFFIRMS station. For example, one may find a fuel array to have a scorch height

potential greater than 10 m (the selected acceptance level) only five days per season. This may be an acceptable amount of exposure. However, by allowing the fuels to accumulate over a fifty year period, the 10 m level may now be potentially exceeded on twenty days, which the manager may consider to be too high an exposure. Similarly, the system may be used to find the degree of fuels treatment necessary to reduce the exposure, or number of days the scorch height can exceed 10 m, to one day per season.

4. The evaluation should include a consideration of the fire behavior's spatial occurrence or probability. This requires a distribution of fire behavior characteristics to be produced, which in turn requires the distribution of fuel array parameters to be evaluated. If these fuel characteristics are randomly sampled within the complex, it is possible to determine the probability of a given level of fire behavior being reached on any point in the complex, or similarly, the proportion of ground area in the stand over which that level of behavior will be reached.

5. Due to the complex nature of the models and the large volumes of data involved, the hazard appraisal system should be computer-based. With the increasing availability of computer services to, and knowledge of, computer hardware at the forest and district offices, this should not be a limiting factor. Indeed, it will reduce the amount of user interaction necessary and minimize the tedium involved and potential of human error.

6. The system's purpose is not one of decision making, but rather of distilling large volumes of data and converting it to meaningful information which is easily interpreted and versatile in its application.

The user will still have to define his levels of hazard acceptability at certain points in the evaluation.

SYSTEM DESIGN

A fire hazard evaluation system was designed as shown in Figure 1. It consists simply of two parallel processes of converting fuels and weather data into distributions and iteratively submitting the information to a fire model which integrates them to produce fire behavior distributions. To make the system completely operational and autonomous requires the weather and fuels information to be stored in machine-readable form with a standard format for access by conversion programs. While weather data is currently being stored in such a standard, computer-accessable format, this is not the case for fuels.

Weather data is available from any established AFFIRMS station at the Colorado State University Univac 1100 facility. The procedure for accessing this data base is outlined by Furman and Brink (1975) and further detailed in Appendix C. Once accessed, these data are converted into frequency and cumulative distributions of wind, temperature, and fuel moistures by time lag class using algorithms developed by the National Fire Danger Rating System Work Unit. (These algorithms are contained in the computer program NEWFIR).

Similarly, randomly sampled fuel data must be converted into fuel characteristic distributions. If this data were collected and stored in standardized format, it would be possible to make all the necessary conversions and create the distributions with a single computer subroutine analagous to the way NEWFIR is used. This subroutine named perhaps FUELPROG, would make this conversion of the raw fuel plot data into fire model fuel parameters.

Both the fire weather and fuel parameter frequency and cumulative distributions and their statistics may be displayed in the system's output. This gives the user the opportunity to examine the shape of the distributions and make inferences on weather and fuel factors and their occurrence.

Finally, the prepared weather and fuel data are submitted to the three-strata fire model. Two algorithms are possible. First, every fuel plot may be run once with every weather day within the fire model to obtain a true historical distribution of the potential behavior. However, with 100 fuel plots and ten years of weather data at 100 days per fire season, this requires 10^5 iterations of the fire model. To reduce the computer run time, storage, and cost requirements, the fire weather information as summarized in the cumulative distribution curves are used rather than the day-by-day data. Each fuel plot is now submitted to the fire model subroutine twenty times, once for each successive 5% cumulative fuel moisture condition. The entire range of weather conditions are therefore considered at twenty discrete points for eachfuel plot. This approach, however, carries with it the implicit assumption that the x% cumulative one-hour fuel moisture occurrs simultaneously with the x% fuel moistures for all other time-lag classes. This is not entirely true as it is possible to have some fuels at their driest levels while others are at their wettest (for example, after a twelve hour rain ending a thirty day drying cycle, the small fuels may be quite wet while the large fuels are still dry).

To reduce the complexities of superimposing several distributions upon each other, the user is allowed to specify the windspeed and ambient temperature at which the fire behavior is estimated. For output, he may declare

the options of graphs and/or tables of the frequency and cumulative distributions of fuels and/or fire weather parameters, as well as the fire variable(s) with which to assess the fuel array's hazard.

DEMONSTRATION OF THE HAZARD EVALUATION SYSTEM

To illustrate the hazard system's processes, flexibility, and interpretive options, a demonstration follows using a hypothetical management problem and real weather and fuels data. Output for the demonstration is reproduced in Appendix A.

Management Problem - Seymore Woods is the ranger on the Grizzly District of the Siwash National Forest. He has charge of a large district that includes broad tracts of extensively-managed forest. He is particularly interested in establishing a tentative management schedule for one such stand containing 250 year old western larch at 4000 to 5500 foot elevation. The stand was last burned in the 1937 Bear Butte Fire. The fire had little effect upon the older larch, and the stand is being succeeded by thirty to forty year old Douglas-fir and white spruce.

Seymore estimates that it will be another forty years before it is feasible to get back to and harvest the stand, so he wants to know (1) what the current hazard is in the stand and (2) how the hazard will change over the next forty years as natural fuels accumulate.

Field Processes - Seymore has heard of the hazard evaluation system from Region, so he asks for information on it. He receives a set of instructions and standard fuel inventory forms, and details his crack fuels inventory crew to the stand to randomly measure fuel plots. Seymore, being a resourceful manager, also directs the crew to sample a nearby stand that burned

in 1887, but escaped the Bear Butte Fire.

In two weeks, Seymore has prepared a standard packet of materials for delivery back to region. In addition to the two sets of inventory sheets, there is a form on which he has specified the AFFIRMS station most representative of the larch stand's potential scorch height at an ambient temperature of 25 degrees Celsius and a 20 foot windspeed of five to ten miles per hour. Scorch height, he feels, will have the greatest impact of any fire variable on the stand's ability to survive a burn. Now Seymore sends his packet into the regional office and awaits his results.

System Processes - To produce the graphs and tables in Appendix A for the demonstration, real data were used. Fuel plots were taken in the West Lakes District of Glacier National Park in 1974-75 and used in this example, as was fifteen years of weather data from the Polebridge, GNP AFFIRMS station.

The weather information was symed from its storage location at Colorado State University to the Region 1 headquarters where it was keypunched onto computer cards. Similarly, the fuel data would, in an autonomous system, be keypunched from the field forms onto cards according to specified format. The two decks of cards are then fed into the computer as the input stream for the program that performs the actual hazard evaluation (TAROT). This program edits the weather data for missing information, and creates, stores, and prints out the fire weather distributions (Tables 1 - 12). The raw fuel data are converted into loads and packing ratios, and stratified according to stand and/or age class. Each stand age class is then input into the three strata fire model (Bevins 1976) with the twenty discrete points of the fire weather cumulative distributions. Output of scorch height proba-

bilities and occurrence over the entire range of historical weather conditions is then produced (Tables 13 - 20).

Because there is no current standard fuels inventory format, the actual process followed in this demonstration was slightly different from the ideal, autonomous system procedure described above. Glacier's fuel data were converted and stored on magnetic tape outside of the TAROT program, which in turn accessed this tape for the necessary information. Histograms of the Glacier National Park fuels data are given in Appendix B (from Bevins and Jeske 1976).

Hazard Interpretation - The next week, Seymore gets back a package of computer printouts from Region along with an explanatory sheet. The printout includes some tables and graphs (Appendix A). Not being too interested in the weather curves at present, he turns to Tables 13 and 14 and consults his guidebook.

Seymore figures the larch stand can survive a scorch height of 15 m; if it gets much higher than that, the trees have a better than 50-50 chance of dying. Furthermore, he is willing to lose a maximum of one-third of his stems as a result of crown scorch. Looking at Table 13 for the 0 - 55 years since burn stand, he picks out the scorch height value of 15 m on the side scale and reads across the table until he finds the percent of the stand area (with a scorch height below 15 m) of 67% or more. The first value greater than 67% is 69.2% in the column corresponding to a fuel moisture cumulative frequency level of 30%. Since he has an approximate 100-day fire season, Seymore can now estimate a thirty-day exposure per year when this stand has the potential of a fire with a scorch height above 15 m on over 30% of the area.

He now turns to Table 14 for a 55-105 year old fuels complex and for a 15 m scorch height over 33% of the stand, he sees his exposure has increased to 65 days per season as a result of the fuels buildup. With this information, he may now make some informed judgements concerning the need for hazard reduction in the stand, or perhaps for an increased fire detection effort in the drainage, over the next forty years.

Alternatively, Seymore may be operating on some financial constraints that limits to 45 the number of days per season that the Bear Butte Lookout, overlooking the larch stand, is manned. For 0-55 year fuel levels, a 33% stand loss is found at the 13 m scorch height, an acceptable level. But for the 55-105 year fuels, the scorch height for the 45th day increased to 23 m, well above Seymore's predetermined limit. Now, if Seymore wants to know exactly what weather he may expect on his typical 45th worst day, he can consult Tables 1 - 12.

The methods of interpreting the fire hazard with respect to potential fire behavior simply involves holding two of three indicators (constraints are the fire behavior level, the exposure time, and the area of occurrence (or probability or confidence of the specified fire behavior level).

POTENTIAL APPLICATIONS

Possible applications of this fire hazard evaluation system may be inferred from the preceding demonstration or from the reader's own experiences and managerial problems. Some of these applications may include,

1. an appraisal of the change in hazard as affected by natural fuels

accumulation, preharvest and harvest treatments, insect attack, or blowdown,

2. an estimate of the amount of fuel reduction necessary to meet a set of hazard constraints,
3. providing a common basis of comparing fire hazard between stands of differing cover types, treatments, and value, to determine hazard reduction priorities and scheduling, and
4. the estimation of hazard reduction costs based upon reduction requirements.

SUMMARY AND CONCLUSIONS

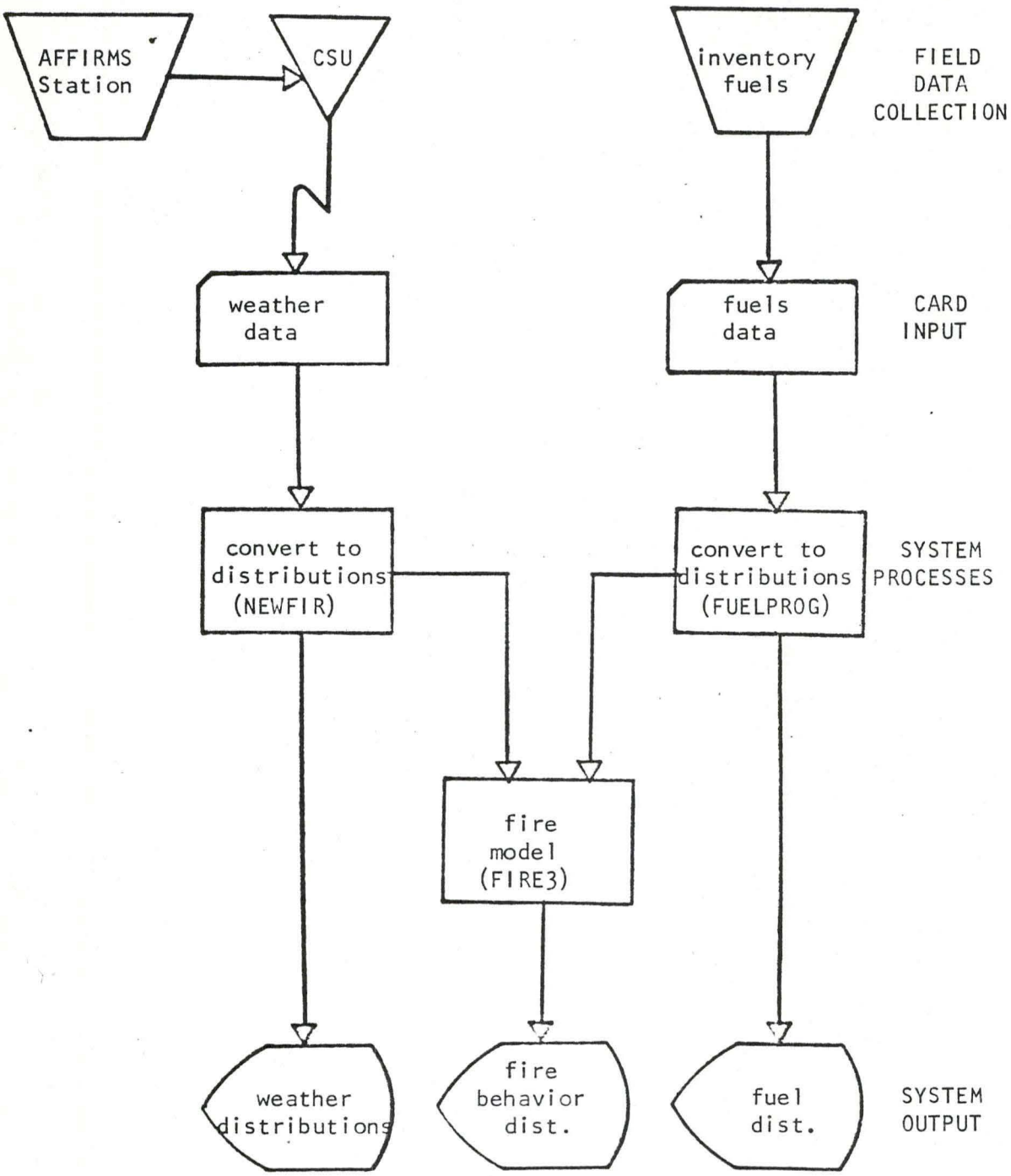
This paper has proposed a fire hazard evaluation system that minimizes user interaction but allows the manager the freedom of specifying certain constraints. It accesses large volumes of data from diverse sources and integrates them via a three strata fire model to produce distributions of important fire behavior variables, the real consequences of hazard. The hazard is therefore evaluated with respect to (1) fire behavior, (2) exposure to that behavior in terms of days per year, and (3) the probability or prevalence of fire behavior exceeding a specific level.

The proposed system has several potential applications relating not only to hazard evaluation and reduction, but also the economics of setting reduction priorities and schedules. Many of these applications are possible under the system structure shown in Figure 1, but may be explicitly addressed by adding new components to the initial design. One such addition, as pre-

viously mentioned, is the possible inclusion of a risk factor to determine the urgency of hazard reduction. A current need is for a standardized method of measuring, recording, keypunching, converting, and storing fuels data. Once such a procedure is established, the system will be autonomous in its functioning and will require only the input of raw data on computer cards to be fully operational.

Finally, the actual use of such a system on a region-wide basis will necessarily require a centralized processing site to which fuels data are sent and AFFIRMS information is symed.

Figure 1 : FIRE HAZARD EVALUATION SYSTEM



Literature Cited

Bevins, Collin D. (1976). Fire modeling for natural fuel situations in Glacier National Park. Proceedings: First Conference on Scientific Research in the National Parks. AIBS conference, November 9-13, New Orleans, LA.

Bevins, Collin D., and Bruce W. Jeske (1976). Spatial and temporal distirbutions of natural fuels in Glacier National Park. Proceedings: First Conference on Scientific Research in the National Parks. AIBS conference, November 9-13, New Orleans, LA.

Furman, R. William, and Glen E. Brink (1975) The national fire weather data library: what it is and how to use it. USDA Forest Service General Technical Report RM-19. Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado. 8 pp.

APPENDIX A

SAMPLE SYSTEM OUTPUT

Tables 1 - 12 show the frequency and cumulative distributions for wind, temperature, one-, ten-, hundred-, and thousand-hour time lag fuel moistures, respectively, first in tabular, and then in graphical form. These data are taken from fifteen years of season weather data collected at the Polebridge, GNP, AFFIRMS station (Station number 240207).

Tables 13 - 16 show the occurrence or probability of scorch height over the twenty successive 5% cumulative fuel moisture levels based upon fuel plots taken in Glacier National Park's West Lakes District. The four tables correspond to 0-55, 55-105, 105-155, and greater than 155 years since burn, respectively.

Tables 17 - 20 are the same as Numbers 13 - 16, with only the 25, 50, 75, and 100% occurrence levels printed out to lend clarity in reading and to present the results in graphical form.

FREQUENCY DISTRIBUTIONS FOR WIND DATA SAMPLE NUMBER 1012 NUMBER OF CLASSES 26

CLASS NO	UPPER LIMIT OF CLASS(MPH)	NUMBER IN CLASS	CUMULATIONS	RELATIVE FREQ (PCT)	CUMULATIVE FREQ (PCT)
1	1.9	69	69	6.8	6.8
2	3.9	177	246	17.5	24.3
3	5.9	253	499	25.0	49.3
4	7.9	193	692	19.1	68.4
5	9.9	119	811	11.8	80.1
6	11.9	101	912	10.0	90.1
7	13.9	44	956	4.3	94.5
8	15.9	29	985	2.9	97.3
9	17.9	10	995	1.0	98.3
10	19.9	11	1006	1.1	99.4
11	21.9	3	1009	.3	99.7
12	23.9	1	1010	.1	99.8
13	25.9	2	1012	.2	100.0
14	27.9	0	1012	0	100.0
15	29.9	0	1012	0	100.0
16	31.9	0	1012	0	100.0
17	33.9	0	1012	0	100.0
18	35.9	0	1012	0	100.0
19	37.9	0	1012	0	100.0
20	39.9	0	1012	0	100.0
21	41.9	0	1012	0	100.0
22	43.9	0	1012	0	100.0
23	45.9	0	1012	0	100.0
24	47.9	0	1012	0	100.0
25	49.9	0	1012	0	100.0
26	51.9	0	1012	0	100.0

MEAN 6.353

STANDARD DEVIATION 3.884

STANDARD ERROR .122

Table 1 : Frequency Distribution Values for Wind Data

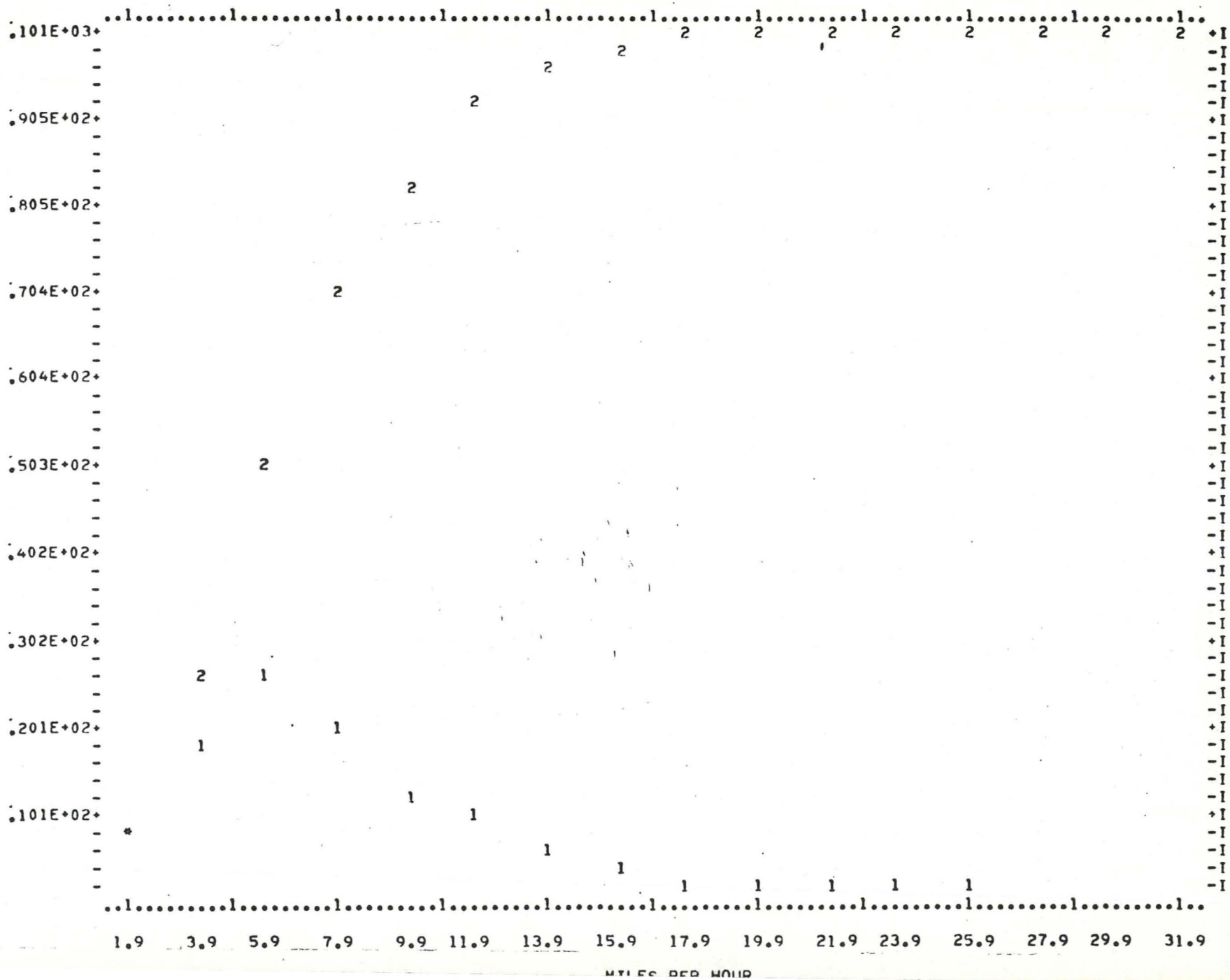


Table 2 : Frequency Distribution Graphs of Wind Data

FREQUENCY DISTRIBUTIONS FOR TEMPERATURE DATA SAMPLE NUMBER 1012 NUMBER OF CLASSES 16

CLASS NO	UPPER LIMIT OF CLASS(F)	NUMBER IN CLASS	CUMULATIONS	RELATIVE FREQ (PCT)	CUMULATIVE FREQ (PCT)
1	29.0	0	0	0	0
2	34.0	0	0	0	0
3	39.0	3	3	.3	.3
4	44.0	9	12	.9	1.2
5	49.0	30	42	3.0	4.2
6	54.0	68	110	6.7	10.9
7	59.0	81	191	8.0	18.9
8	64.0	114	305	11.3	30.1
9	69.0	109	414	10.8	40.9
10	74.0	118	532	11.7	52.6
11	79.0	164	696	16.2	68.8
12	84.0	142	838	14.0	82.8
13	89.0	116	954	11.5	94.3
14	94.0	45	999	4.4	98.7
15	99.0	13	1012	1.3	100.0
16	*	0	1012	0	100.0

MEAN 71.672

STANDARD DEVIATION 12.493

STANDARD ERROR .393

Table 3 : Frequency Distribution Values for Temperature Data

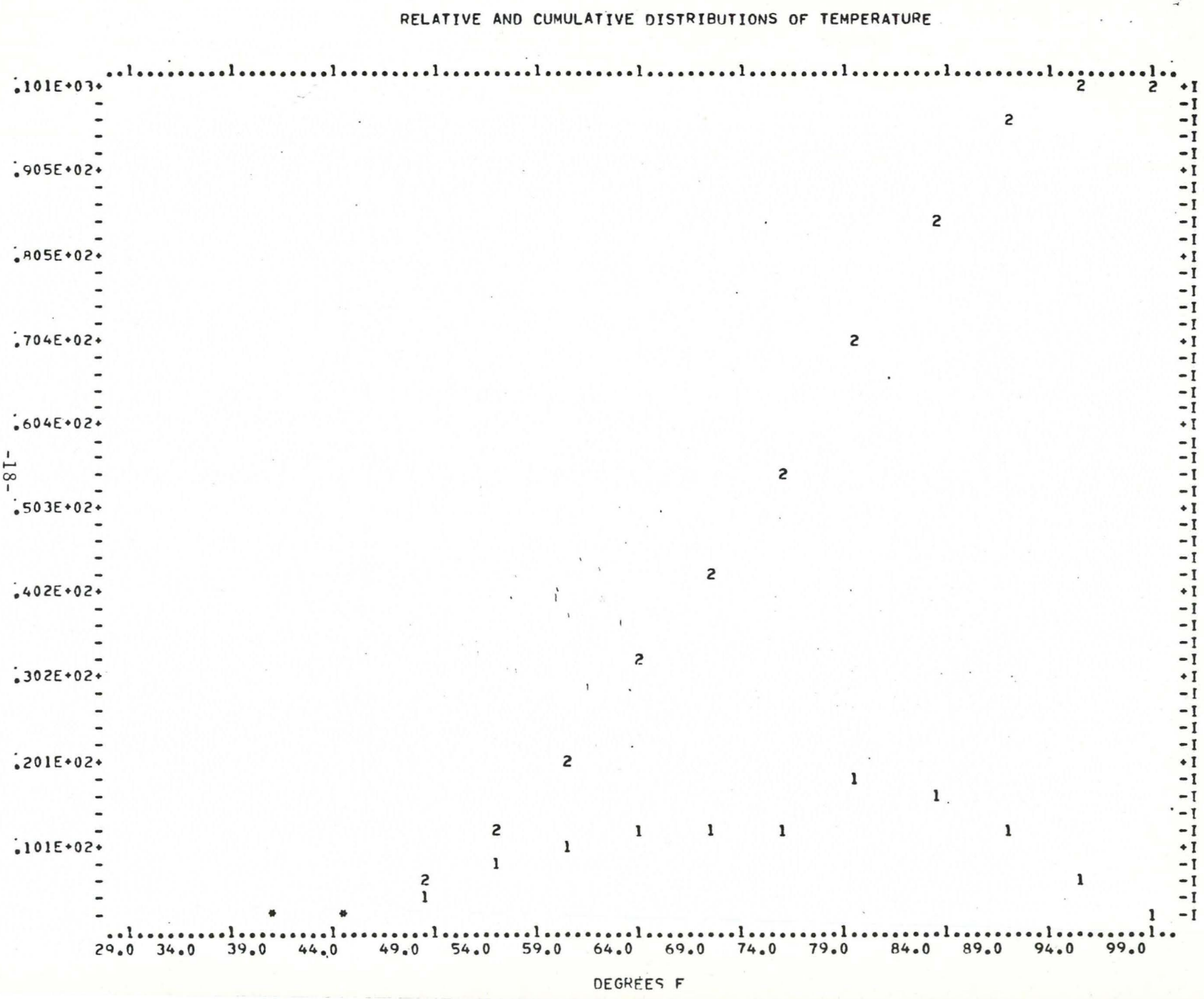


Table 4 : Frequency Distribution Graph of Temperature Data

FREQUENCY DISTRIBUTIONS FOR FUEL MOISTURES, JHR=1 SAMPLE NUMBER 1006 NUMBER OF CLASSES 28

CLASS NO	UPPER LIMIT OF CLASS(PCT)	NUMBER IN CLASS	CUMULATIONS	RELATIVE FREQ (PCT)	CUMULATIVE FREQ (PCT)
1	1.0	98	98	9.7	9.7
2	2.0	186	284	18.5	28.2
3	3.0	165	449	16.4	44.6
4	4.0	100	549	9.9	54.6
5	5.0	68	617	6.8	61.3
6	6.0	65	682	6.5	67.8
7	7.0	50	732	5.0	72.8
8	8.0	43	775	4.3	77.0
9	9.0	50	825	5.0	82.0
10	10.0	30	855	3.0	85.0
11	11.0	18	873	1.8	86.8
12	12.0	16	889	1.6	88.4
13	13.0	11	900	1.1	89.5
14	14.0	12	912	1.2	90.7
15	15.0	6	918	.6	91.3
16	16.0	5	923	.5	91.7
17	17.0	1	924	.1	91.8
18	18.0	1	925	.1	91.9
19	19.0	1	926	.1	92.0
20	20.0	0	926	0	92.0
21	21.0	0	926	0	92.0
22	22.0	0	926	0	92.0
23	23.0	1	927	.1	92.1
24	24.0	1	928	.1	92.2
25	25.0	78	1006	7.8	100.0
26	26.0	0	1006	0	100.0
27	27.0	0	1006	0	100.0
28	28.0	0	1006	0	100.0

MEAN 6.422

STANDARD DEVIATION 6.377

STANDARD ERROR .201

Table 5 : Distribution Values for One Hour Fuel Moistures

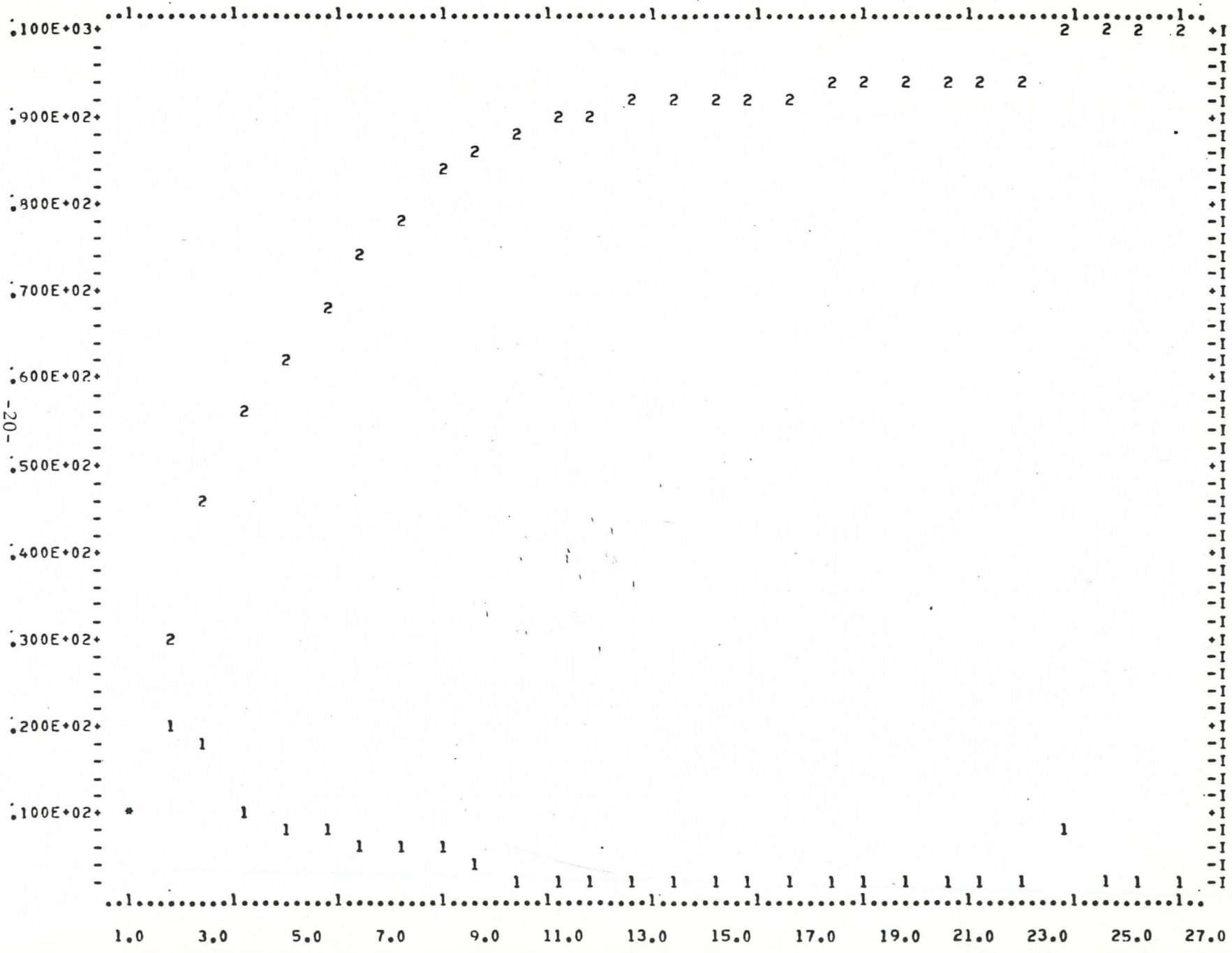


Table 6 : Frequency Distribution Graph of One Hour Fuel Moistures

FREQUENCY DISTRIBUTIONS FOR FUEL MOISTURES, JHR=2 SAMPLE NUMBER 1006 NUMBER OF CLASSES 28

CLASS NO	UPPER LIMIT OF CLASS(PCT)	NUMBER IN CLASS	CUMULATIONS	RELATIVE FREQ (PCT)	CUMULATIVE FREQ (PCT)
1	1.0	0	0	0	0
2	2.0	168	168	16.7	16.7
3	3.0	130	298	12.9	29.6
4	4.0	85	383	8.4	38.1
5	5.0	75	458	7.5	45.5
6	6.0	54	512	5.4	50.9
7	7.0	56	568	5.6	56.5
8	8.0	52	620	5.2	61.6
9	9.0	58	678	5.8	67.4
10	10.0	46	724	4.6	72.0
11	11.0	48	772	4.8	76.7
12	12.0	21	793	2.1	78.8
13	13.0	34	827	3.4	82.2
14	14.0	23	850	2.3	84.5
15	15.0	18	868	1.8	86.3
16	16.0	7	875	.7	87.0
17	17.0	10	885	1.0	88.0
18	18.0	8	893	.8	88.8
19	19.0	6	899	.6	89.4
20	20.0	6	905	.6	90.0
21	21.0	2	907	.2	90.2
22	22.0	3	910	.3	90.5
23	23.0	2	912	.2	90.7
24	24.0	2	914	.2	90.9
25	25.0	82	996	8.2	99.0
26	26.0	0	996	0	99.0
27	27.0	1	997	.1	99.1
28	28.0	9	1006	.9	100.0

MEAN 8.573

STANDARD DEVIATION 7.169

STANDARD ERROR .226

Table 7 : Distribution Values for Ten Hour Fuel Moistures

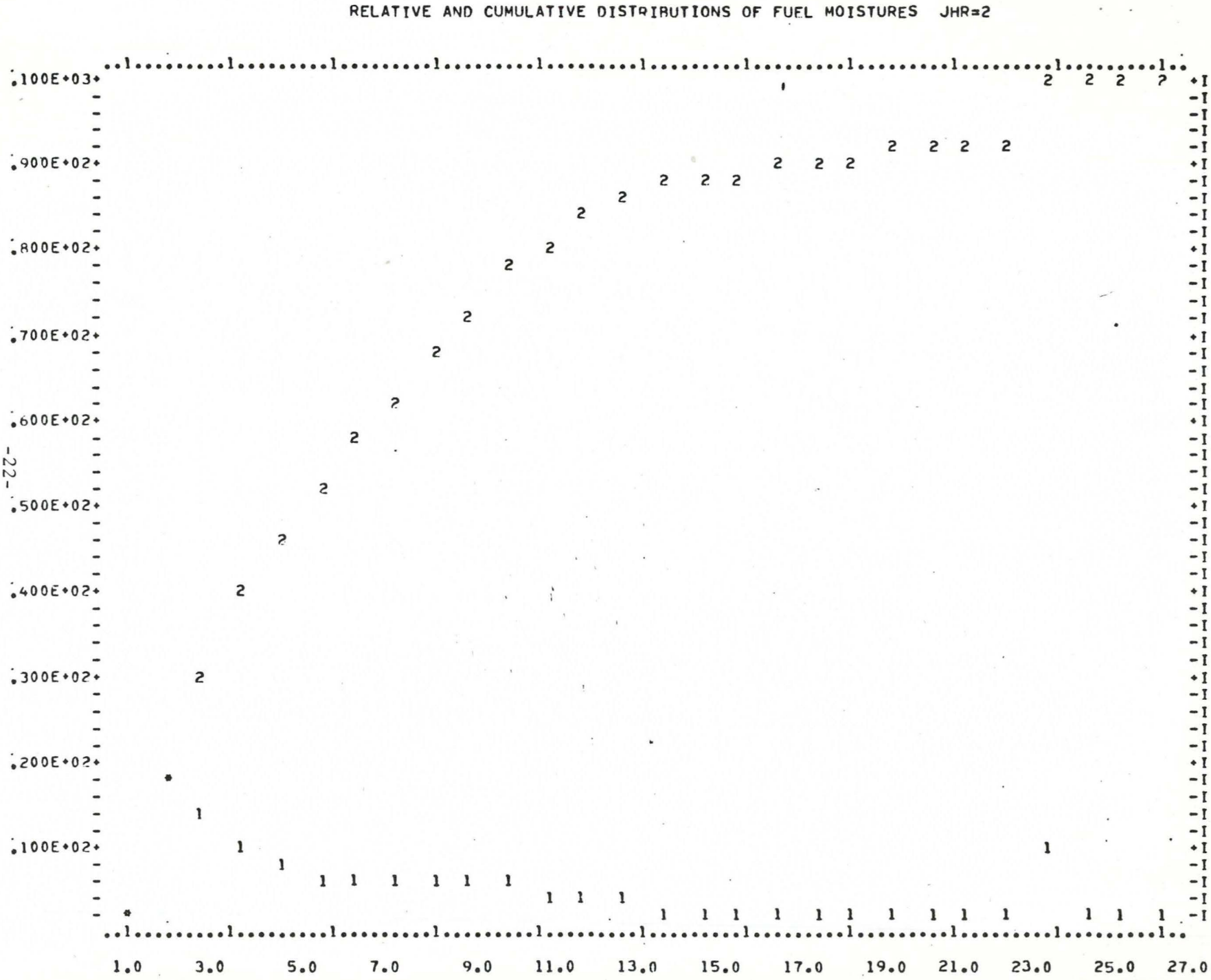


Table 8 : Frequency Distribution Graph of Ten Hour Fuel Moistures

FREQUENCY DISTRIBUTIONS FOR FUEL MOISTURES, JHR=3 SAMPLE NUMBER 1006 NUMBER OF CLASSES 28

CLASS NO	UPPER LIMIT OF CLASS(PCT)	NUMBER IN CLASS	CUMULATIONS	RELATIVE FREQ (PCT)	CUMULATIVE FREQ (PCT)
1	1.0	0	0	0	0
2	2.0	0	0	0	0
3	3.0	0	0	0	0
4	4.0	0	0	0	0
5	5.0	0	0	0	0
6	6.0	0	0	0	0
7	7.0	1	1	.1	.1
8	8.0	3	4	.3	.4
9	9.0	10	14	1.0	1.4
10	10.0	21	35	2.1	3.5
11	11.0	61	96	6.1	9.5
12	12.0	108	204	10.7	20.3
13	13.0	199	403	19.8	40.1
14	14.0	167	570	16.6	56.7
15	15.0	141	711	14.0	70.7
16	16.0	117	828	11.6	82.3
17	17.0	64	892	6.4	88.7
18	18.0	47	939	4.7	93.3
19	19.0	16	955	1.6	94.9
20	20.0	18	973	1.8	96.7
21	21.0	7	980	.7	97.4
22	22.0	3	983	.3	97.7
23	23.0	3	986	.3	98.0
24	24.0	10	996	1.0	99.0
25	25.0	2	998	.2	99.2
26	26.0	3	1001	.3	99.5
27	27.0	0	1001	0	99.5
28	28.0	5	1006	.5	100.0

MEAN 14.520

STANDARD DEVIATION 2.882

STANDARD ERROR .091

Table 9 : Distribution Values for Hundred Hour Fuel Moistures

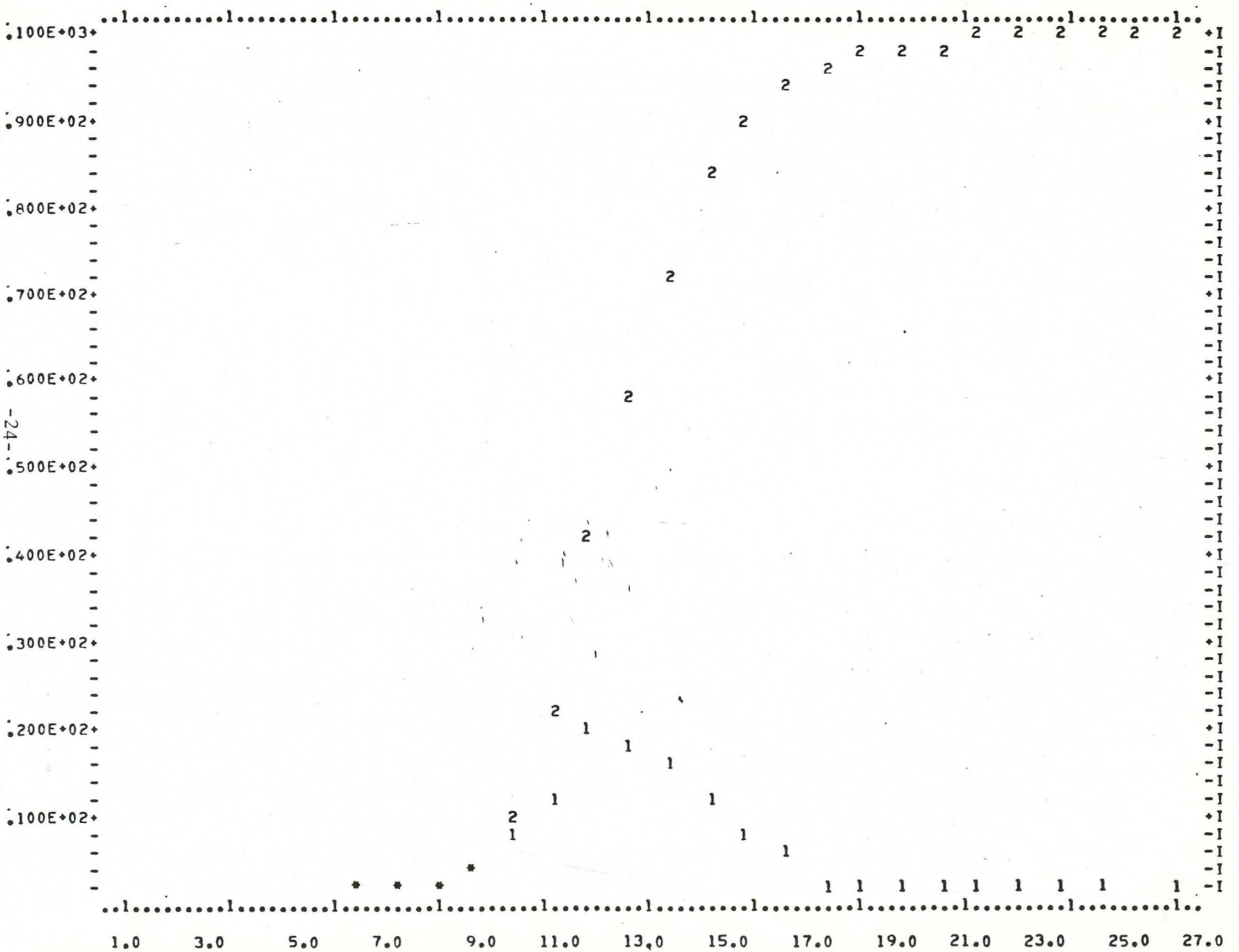


Table 10 : Frequency Distribution Graphs of Hundred Hour Fuel Moistures

FREQUENCY DISTRIBUTIONS FOR FUEL MOISTURES, JHR=4 SAMPLE NUMBER 1006 NUMBER OF CLASSES 28

CLASS NO	UPPER LIMIT OF CLASS(PCT)	NUMBER IN CLASS	CUMULATIONS	RELATIVE FREQ (PCT)	CUMULATIVE FREQ (PCT)
1	1.0	0	0	0	0
2	2.0	0	0	0	0
3	3.0	0	0	0	0
4	4.0	0	0	0	0
5	5.0	0	0	0	0
6	6.0	0	0	0	0
7	7.0	0	0	0	0
8	8.0	0	0	0	0
9	9.0	0	0	0	0
10	10.0	0	0	0	0
11	11.0	0	0	0	0
12	12.0	51	51	5.1	5.1
13	13.0	41	92	4.1	9.1
14	14.0	63	155	6.3	15.4
15	15.0	157	312	15.6	31.0
16	16.0	184	496	18.3	49.3
17	17.0	152	648	15.1	64.4
18	18.0	74	722	7.4	71.8
19	19.0	35	757	3.5	75.2
20	20.0	39	796	3.9	79.1
21	21.0	39	835	3.9	83.0
22	22.0	27	862	2.7	85.7
23	23.0	26	888	2.6	88.3
24	24.0	21	909	2.1	90.4
25	25.0	23	932	2.3	92.6
26	26.0	18	950	1.8	94.4
27	27.0	15	965	1.5	95.9
28	28.0	41	1006	4.1	100.0

MEAN 17.724

STANDARD DEVIATION 4.085

STANDARD ERROR .129

Table 11 : Distribution Values for Thousand Hour Fuel Moistures

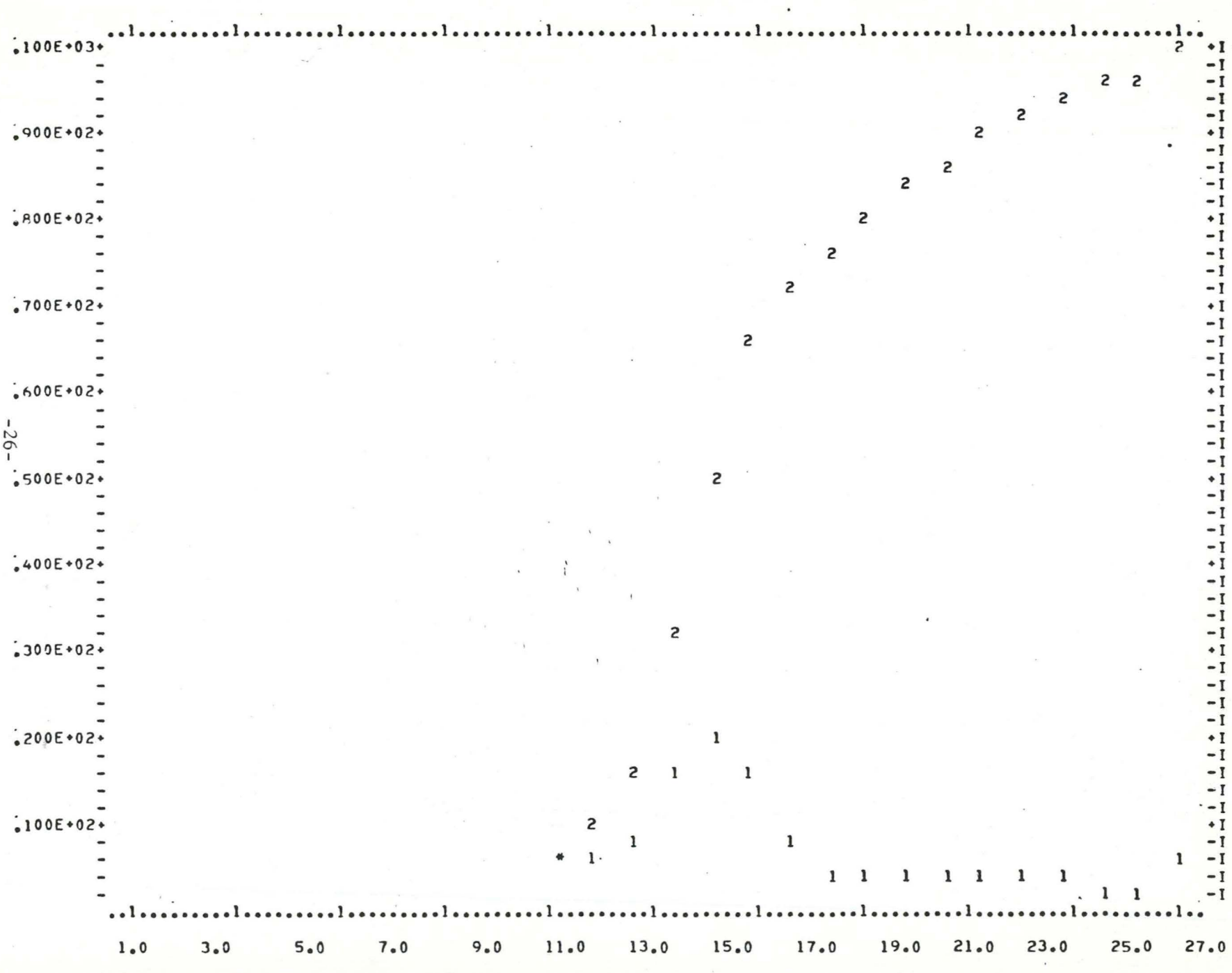


Table 12 : Frequency Distribution Graph of Thousand Hour Fuel Moistures

SCORCH HEIGHT DISTRIBUTIONS FOR STANDS BETWEEN 0 AND 55 YEARS OF AGE

CUMULATIVE SCORCH HEIGHT DISTIBUTIONS VS FIVE PER CENT CUMULATIVE

INCREMENTS OF FUEL MOISTURE FOR EACH FUEL CLASS

SCORCH HEIGHT (TRUNCATED) (METERS)																			
35	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
34	76.9	69.2	69.2	69.2	69.2	69.2	69.2	69.2	69.2	69.2	69.2	69.2	69.2	92.3	92.3	100.0	100.0	100.0	100.0	100.0	100.0
33	76.9	69.2	69.2	69.2	69.2	69.2	69.2	69.2	69.2	69.2	69.2	69.2	69.2	92.3	92.3	100.0	100.0	100.0	100.0	100.0	100.0
32	76.9	69.2	69.2	69.2	69.2	69.2	69.2	69.2	69.2	69.2	69.2	69.2	69.2	92.3	92.3	92.3	100.0	100.0	100.0	100.0	100.0
31	69.2	69.2	69.2	69.2	69.2	69.2	69.2	69.2	69.2	69.2	69.2	69.2	69.2	92.3	92.3	92.3	92.3	100.0	100.0	100.0	100.0
30	69.2	69.2	69.2	69.2	69.2	69.2	69.2	69.2	69.2	69.2	69.2	69.2	69.2	92.3	92.3	92.3	92.3	100.0	100.0	100.0	100.0
29	69.2	69.2	69.2	69.2	69.2	69.2	69.2	69.2	69.2	69.2	69.2	69.2	69.2	92.3	92.3	92.3	92.3	100.0	100.0	100.0	100.0
28	69.2	69.2	69.2	69.2	69.2	69.2	69.2	69.2	69.2	69.2	69.2	69.2	69.2	92.3	92.3	92.3	92.3	100.0	100.0	100.0	100.0
27	69.2	69.2	69.2	69.2	69.2	69.2	69.2	69.2	69.2	69.2	69.2	69.2	69.2	92.3	92.3	92.3	92.3	92.3	100.0	100.0	100.0
26	61.5	69.2	69.2	69.2	69.2	69.2	69.2	69.2	69.2	69.2	69.2	69.2	69.2	92.3	92.3	92.3	92.3	92.3	100.0	100.0	100.0
25	61.5	69.2	69.2	69.2	69.2	69.2	69.2	69.2	69.2	69.2	69.2	69.2	69.2	92.3	92.3	92.3	92.3	92.3	100.0	100.0	100.0
24	61.5	69.2	69.2	69.2	69.2	69.2	69.2	69.2	69.2	69.2	69.2	69.2	69.2	92.3	92.3	92.3	92.3	92.3	100.0	100.0	100.0
23	61.5	69.2	69.2	69.2	69.2	69.2	69.2	69.2	69.2	69.2	69.2	69.2	69.2	92.3	92.3	92.3	92.3	92.3	100.0	100.0	100.0
22	61.5	69.2	69.2	69.2	69.2	69.2	69.2	69.2	69.2	69.2	69.2	69.2	69.2	92.3	92.3	92.3	92.3	92.3	100.0	100.0	100.0
21	61.5	61.5	69.2	69.2	69.2	69.2	69.2	69.2	69.2	69.2	69.2	69.2	69.2	92.3	92.3	92.3	92.3	92.3	100.0	100.0	100.0
20	61.5	61.5	69.2	69.2	69.2	69.2	69.2	69.2	69.2	69.2	69.2	69.2	69.2	92.3	92.3	92.3	92.3	92.3	100.0	100.0	100.0
19	61.5	61.5	69.2	69.2	69.2	69.2	69.2	69.2	69.2	69.2	69.2	69.2	69.2	92.3	92.3	92.3	92.3	92.3	100.0	100.0	100.0
18	61.5	61.5	69.2	69.2	69.2	69.2	69.2	69.2	69.2	69.2	69.2	69.2	69.2	92.3	92.3	92.3	92.3	92.3	100.0	100.0	100.0
17	61.5	53.8	61.5	61.5	69.2	69.2	69.2	69.2	69.2	69.2	69.2	69.2	69.2	92.3	92.3	92.3	92.3	92.3	100.0	100.0	100.0
16	61.5	53.8	61.5	61.5	61.5	69.2	69.2	69.2	69.2	69.2	69.2	69.2	69.2	92.3	92.3	92.3	92.3	92.3	100.0	100.0	100.0
15	61.5	53.8	61.5	61.5	61.5	69.2	69.2	69.2	69.2	69.2	69.2	69.2	69.2	92.3	92.3	92.3	92.3	92.3	100.0	100.0	100.0
14	61.5	53.8	61.5	61.5	61.5	61.5	61.5	61.5	69.2	69.2	69.2	69.2	92.3	92.3	92.3	92.3	92.3	92.3	100.0	100.0	100.0
13	53.8	46.2	61.5	61.5	61.5	61.5	61.5	61.5	69.2	69.2	69.2	69.2	92.3	92.3	92.3	92.3	92.3	92.3	100.0	100.0	100.0
12	53.8	46.2	53.8	61.5	61.5	61.5	61.5	61.5	61.5	61.5	69.2	69.2	92.3	92.3	92.3	92.3	92.3	92.3	100.0	100.0	100.0
11	46.2	46.2	53.8	61.5	61.5	61.5	61.5	61.5	61.5	61.5	61.5	61.5	92.3	92.3	92.3	92.3	92.3	92.3	100.0	100.0	100.0
10	46.2	38.5	53.8	61.5	61.5	61.5	61.5	61.5	61.5	61.5	61.5	61.5	92.3	92.3	92.3	92.3	92.3	92.3	92.3	100.0	100.0
9	46.2	38.5	38.5	53.8	53.8	61.5	61.5	61.5	61.5	61.5	61.5	61.5	92.3	92.3	92.3	92.3	92.3	92.3	100.0	100.0	100.0
8	46.2	38.5	38.5	46.2	53.8	53.8	53.8	53.8	61.5	61.5	61.5	61.5	76.9	84.6	92.3	92.3	92.3	92.3	100.0	100.0	100.0
7	38.5	38.5	38.5	38.5	38.5	46.2	46.2	46.2	53.8	53.8	53.8	53.8	76.9	76.9	76.9	84.6	92.3	92.3	100.0	100.0	100.0
6	30.8	30.8	38.5	38.5	38.5	46.2	46.2	46.2	46.2	46.2	46.2	46.2	69.2	76.9	76.9	76.9	76.9	92.3	100.0	100.0	100.0
5	15.4	15.4	38.5	38.5	38.5	38.5	38.5	38.5	46.2	46.2	46.2	46.2	69.2	69.2	69.2	69.2	76.9	92.3	100.0	100.0	100.0
4	0	0	30.8	30.8	30.8	38.5	38.5	38.5	38.5	38.5	38.5	38.5	61.5	61.5	61.5	61.5	69.2	92.3	100.0	100.0	100.0
3	0	0	30.8	30.8	30.8	30.8	30.8	30.8	30.8	30.8	30.8	30.8	38.5	38.5	38.5	46.2	61.5	76.9	100.0	100.0	100.0
2	0	0	0	7.7	15.4	23.1	23.1	23.1	30.8	30.8	30.8	30.8	38.5	38.5	38.5	38.5	38.5	76.9	100.0	100.0	100.0
1	0	0	0	0	0	0	0	0	0	0	0	0	0	7.7	7.7	23.1	23.1	46.2	100.0	100.0	100.0

5.0 10.0 15.0 20.0 25.0 30.0 35.0 40.0 45.0 50.0 55.0 60.0 65.0 70.0 75.0 80.0 85.0 90.0 95.0 100.0

CUMULATIVE FUEL MOISTURE LEVEL

THE NUMBER OF PLOTS USED 13

Table 13 : Scorch Height Distributions

SCORCH HEIGHT DISTRIBUTIONS FOR STANDS BETWEEN 55 AND 105 YEARS OF AGE

CUMULATIVE SCORCH HEIGHT DISTIBUTIONS VS FIVE PER CENT CUMULATIVE

INCREMENTS OF FUEL MOISTURE FOR EACH FUEL CLASS

Table 14 : Scorch Height Distributions

SCORCH HEIGHT (TRUNCATED) (METERS)																				
35	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
34	67.9	62.3	62.3	66.0	66.0	69.8	69.8	69.8	71.7	71.7	71.7	71.7	84.9	84.9	86.8	86.8	90.6	96.2	100.0	100.0
33	66.0	62.3	62.3	66.0	66.0	69.8	69.8	69.8	71.7	71.7	71.7	71.7	84.9	84.9	86.8	86.8	90.6	96.2	100.0	100.0
32	66.0	62.3	62.3	64.2	64.2	69.8	69.8	69.8	71.7	71.7	71.7	71.7	84.9	84.9	84.9	86.8	88.7	96.2	100.0	100.0
31	66.0	62.3	62.3	62.3	64.2	66.0	66.0	66.0	71.7	71.7	71.7	71.7	84.9	84.9	84.9	84.9	86.8	96.2	100.0	100.0
30	66.0	62.3	62.3	62.3	62.3	66.0	66.0	66.0	71.7	71.7	71.7	71.7	84.9	84.9	84.9	84.9	86.8	96.2	100.0	100.0
29	66.0	60.4	62.3	62.3	62.3	66.0	66.0	66.0	69.8	69.8	71.7	71.7	84.9	84.9	84.9	84.9	86.8	94.3	100.0	100.0
28	66.0	60.4	62.3	62.3	62.3	66.0	66.0	66.0	69.8	69.8	71.7	71.7	84.9	84.9	84.9	84.9	86.8	94.3	100.0	100.0
27	66.0	58.5	62.3	62.3	62.3	66.0	66.0	66.0	69.8	69.8	71.7	71.7	84.9	84.9	84.9	84.9	84.9	94.3	100.0	100.0
26	66.0	56.6	62.3	62.3	62.3	64.2	64.2	64.2	66.0	66.0	69.8	69.8	84.9	84.9	84.9	84.9	84.9	94.3	100.0	100.0
25	64.2	56.6	62.3	62.3	62.3	64.2	64.2	64.2	66.0	66.0	69.8	69.8	84.9	84.9	84.9	84.9	84.9	92.5	100.0	100.0
24	62.3	56.6	60.4	62.3	62.3	62.3	62.3	62.3	66.0	66.0	69.8	69.8	84.9	84.9	84.9	84.9	84.9	92.5	100.0	100.0
23	62.3	56.6	60.4	62.3	62.3	62.3	62.3	62.3	66.0	66.0	66.0	66.0	84.9	84.9	84.9	84.9	84.9	92.5	100.0	100.0
22	58.5	54.7	60.4	62.3	62.3	62.3	62.3	62.3	64.2	64.2	66.0	66.0	84.9	84.9	84.9	84.9	84.9	92.5	100.0	100.0
21	54.5	54.7	60.4	60.4	62.3	62.3	62.3	62.3	62.3	62.3	66.0	66.0	83.0	84.9	84.9	84.9	84.9	92.5	100.0	100.0
20	54.7	50.9	56.6	60.4	60.4	62.3	62.3	62.3	62.3	62.3	64.2	64.2	83.0	84.9	84.9	84.9	84.9	92.5	100.0	100.0
19	54.7	50.9	54.7	56.6	56.6	62.3	62.3	62.3	62.3	62.3	62.3	62.3	77.4	83.0	84.9	84.9	84.9	92.5	100.0	100.0
18	54.7	50.9	54.7	56.6	56.6	60.4	60.4	60.4	62.3	62.3	62.3	62.3	77.4	77.4	83.0	83.0	84.9	90.6	100.0	100.0
17	50.9	50.9	50.9	54.7	54.7	60.4	60.4	60.4	60.4	60.4	62.3	62.3	75.5	75.5	77.4	83.0	84.9	90.6	100.0	100.0
16	50.9	50.9	50.9	54.7	54.7	58.5	58.5	58.5	60.4	60.4	60.4	60.4	75.5	75.5	75.5	77.4	84.9	90.6	100.0	100.0
15	49.1	45.3	49.1	50.9	54.7	56.6	56.6	56.6	60.4	60.4	60.4	60.4	73.6	75.5	75.5	75.5	81.1	88.7	100.0	100.0
14	45.3	43.4	47.2	49.1	49.1	56.6	56.6	56.6	58.5	58.5	60.4	60.4	73.6	73.6	73.6	75.5	75.5	86.8	100.0	100.0
13	45.3	39.6	47.2	49.1	49.1	52.8	52.8	52.8	56.6	56.6	60.4	60.4	71.7	73.6	73.6	73.6	75.5	84.9	100.0	100.0
12	43.4	37.7	45.3	47.2	47.2	50.9	50.9	50.9	54.7	54.7	58.5	58.5	71.7	71.7	73.6	73.6	75.5	84.9	100.0	100.0
11	41.5	34.0	45.3	47.2	47.2	49.1	49.1	49.1	52.8	52.8	54.7	54.7	69.8	71.7	71.7	71.7	73.6	84.9	100.0	100.0
10	37.7	34.0	41.5	47.2	47.2	49.1	49.1	49.1	50.9	50.9	52.8	52.8	67.9	69.8	71.7	71.7	73.6	84.9	100.0	100.0
9	37.7	32.1	39.6	39.6	43.4	47.2	47.2	47.2	49.1	49.1	52.8	52.8	64.2	66.0	67.9	69.8	71.7	83.0	100.0	100.0
8	30.2	30.2	34.0	39.6	39.6	45.3	45.3	45.3	47.2	47.2	49.1	49.1	64.2	64.2	64.2	66.0	69.8	83.0	100.0	100.0
7	26.4	24.5	32.1	35.8	35.8	41.5	41.5	41.5	45.3	45.3	45.3	45.3	60.4	60.4	62.3	64.2	66.0	81.1	100.0	100.0
6	20.8	18.9	28.3	30.2	30.2	37.7	37.7	37.7	41.5	41.5	45.3	45.3	58.5	58.5	60.4	60.4	64.2	77.4	100.0	100.0
5	11.3	9.4	26.4	30.2	30.2	30.2	30.2	30.2	35.8	35.8	37.7	37.7	56.6	58.5	58.5	58.5	60.4	73.6	100.0	100.0
4	3.8	3.8	17.0	20.8	20.8	30.2	30.2	30.2	30.2	30.2	32.1	32.1	49.1	50.9	54.7	54.7	58.5	69.8	100.0	100.0
3	3.8	3.8	9.4	17.0	18.9	18.9	20.8	20.8	22.6	22.6	28.3	28.3	43.4	43.4	45.3	45.3	49.1	64.2	100.0	100.0
2	1.9	0	1.9	3.8	3.8	11.3	11.3	11.3	17.0	17.0	18.9	18.9	32.1	34.0	37.7	41.5	43.4	58.5	100.0	100.0
1	0	0	0	0	0	0	0	0	0	0	1.9	1.9	5.7	9.4	13.2	15.1	20.8	39.6	96.2	96.2
	5.0	10.0	15.0	20.0	25.0	30.0	35.0	40.0	45.0	50.0	55.0	60.0	65.0	70.0	75.0	80.0	85.0	90.0	95.0	100.0

CUMULATIVE FUEL MOISTURE LEVEL

THE NUMBER OF PLOTS USED 53

SCORCH HEIGHT DISTRIBUTIONS FOR STANDS BETWEEN 105 AND 155 YEARS OF AGE

CUMULATIVE SCORCH HEIGHT DISTIBUTIONS VS FIVE PER CENT CUMULATIVE

INCREMENTS OF FUEL MOISTURE FOR EACH FUEL CLASS

Table 15 : Scorch Height Distributions

SCORCH HEIGHT (TRUNCATED) (METERS)	5.0	10.0	15.0	20.0	25.0	30.0	35.0	40.0	45.0	50.0	55.0	60.0	65.0	70.0	75.0	80.0	85.0	90.0	95.0	100.0
35	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
34	74.4	74.4	74.4	76.7	76.7	76.7	76.7	76.7	76.7	76.7	76.7	76.7	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
33	74.4	74.4	74.4	74.4	74.4	76.7	76.7	76.7	76.7	76.7	76.7	76.7	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
32	72.1	74.4	74.4	74.4	74.4	76.7	76.7	76.7	76.7	76.7	76.7	76.7	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
31	72.1	72.1	72.1	74.4	74.4	76.7	76.7	76.7	76.7	76.7	76.7	76.7	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
30	72.1	72.1	72.1	72.1	72.1	74.4	76.7	76.7	76.7	76.7	76.7	76.7	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
29	69.8	69.8	69.8	72.1	72.1	74.4	74.4	74.4	76.7	76.7	76.7	76.7	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
28	69.8	69.8	69.8	69.8	69.8	74.4	74.4	74.4	76.7	76.7	76.7	76.7	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
27	65.1	67.4	69.8	69.8	69.8	74.4	74.4	74.4	74.4	74.4	76.7	76.7	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
26	65.1	67.4	67.4	69.8	69.8	72.1	72.1	72.1	74.4	74.4	74.4	74.4	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
25	60.5	65.1	67.4	67.4	67.4	69.8	72.1	72.1	74.4	74.4	74.4	74.4	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
24	58.1	65.1	65.1	65.1	67.4	69.8	69.8	69.8	72.1	74.4	74.4	74.4	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
23	58.1	65.1	65.1	65.1	65.1	69.8	69.8	69.8	72.1	72.1	74.4	74.4	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
22	58.1	62.8	65.1	65.1	65.1	67.4	67.4	67.4	69.8	69.8	72.1	72.1	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
21	55.8	60.5	65.1	65.1	65.1	67.4	67.4	67.4	69.8	69.8	69.8	69.8	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
20	51.2	55.8	60.5	65.1	65.1	65.1	65.1	65.1	67.4	69.8	69.8	69.8	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
19	51.2	55.8	60.5	60.5	60.5	65.1	65.1	65.1	67.4	67.4	69.8	69.8	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
18	51.2	53.5	58.1	60.5	60.5	65.1	65.1	65.1	65.1	65.1	67.4	67.4	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
17	48.8	48.8	55.8	60.5	60.5	60.5	60.5	60.5	65.1	65.1	67.4	67.4	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
16	46.5	46.5	55.8	58.1	60.5	60.5	60.5	60.5	62.8	62.8	65.1	65.1	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
15	46.5	46.5	55.8	55.8	58.1	60.5	60.5	60.5	60.5	60.5	62.8	62.8	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
14	46.5	46.5	51.2	55.8	55.8	60.5	60.5	60.5	60.5	60.5	60.5	60.5	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
13	46.5	41.9	51.2	53.5	53.5	60.5	60.5	60.5	60.5	60.5	60.5	60.5	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
12	46.5	41.9	48.8	51.2	51.2	55.8	55.8	55.8	58.1	58.1	60.5	60.5	97.7	100.0	100.0	100.0	100.0	100.0	100.0	100.0
11	46.5	39.5	48.8	48.8	48.8	53.5	53.5	53.5	58.1	58.1	58.1	58.1	97.7	97.7	97.7	100.0	100.0	100.0	100.0	100.0
10	44.2	37.2	44.2	48.8	48.8	51.2	51.2	51.2	55.8	55.8	58.1	58.1	97.7	97.7	97.7	97.7	100.0	100.0	100.0	100.0
9	37.2	30.2	41.9	46.5	46.5	48.8	48.8	48.8	53.5	53.5	55.8	55.8	97.7	97.7	97.7	97.7	97.7	100.0	100.0	100.0
8	30.9	23.3	39.5	44.2	44.2	46.5	46.5	46.5	48.8	48.8	53.5	53.5	97.7	97.7	97.7	97.7	97.7	97.7	100.0	100.0
7	20.9	20.9	34.9	41.9	41.9	46.5	46.5	46.5	46.5	46.5	48.8	48.8	90.7	93.0	95.3	97.7	97.7	100.0	100.0	100.0
6	18.6	11.6	30.2	37.2	37.2	41.9	41.9	41.9	44.2	44.2	46.5	46.5	90.7	90.7	90.7	93.0	97.7	100.0	100.0	100.0
5	11.6	7.0	18.6	30.2	32.6	37.2	37.2	37.2	39.5	39.5	41.9	41.9	88.4	90.7	90.7	90.7	90.7	100.0	100.0	100.0
4	0	2.3	14.0	16.3	23.3	27.9	27.9	27.9	37.2	37.2	37.2	37.2	81.4	86.0	88.4	88.4	90.7	97.7	100.0	100.0
3	0	0	7.0	16.3	16.3	16.3	16.3	16.3	25.6	25.6	27.9	27.9	62.8	67.4	69.8	72.1	81.4	97.7	100.0	100.0
2	0	0	2.3	2.3	7.0	7.0	7.0	7.0	11.6	11.6	16.3	16.3	30.2	37.2	44.2	44.2	48.8	88.4	100.0	100.0
1	0	0	0	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	4.7	7.0	7.0	9.3	9.3	53.5	100.0	100.0

CUMULATIVE FUEL MOISTURE LEVEL

THE NUMBER OF PLOTS USED 43

SCORCH HEIGHT DISTRIBUTIONS FOR STANDS BETWEEN 155 AND 300 YEARS OF AGE

CUMULATIVE SCORCH HEIGHT DISTIBUTIONS VS FIVE PER CENT CUMULATIVE

INCREMENTS OF FUEL MOISTURE FOR EACH FUEL CLASS

SCORCH HEIGHT (TRUNCATED) (METERS)																			
35	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
34	52.5	50.0	52.5	55.0	55.0	57.5	57.5	57.5	57.5	57.5	60.0	60.0	92.5	92.5	95.0	95.0	95.0	100.0	100.0	100.0
33	52.5	50.0	52.5	55.0	55.0	57.5	57.5	57.5	57.5	57.5	57.5	57.5	92.5	92.5	92.5	95.0	95.0	100.0	100.0	100.0
32	52.5	50.0	52.5	55.0	55.0	57.5	57.5	57.5	57.5	57.5	57.5	57.5	92.5	92.5	92.5	95.0	95.0	100.0	100.0	100.0
31	52.5	50.0	52.5	52.5	55.0	55.0	55.0	55.0	57.5	57.5	57.5	57.5	92.5	92.5	92.5	92.5	95.0	100.0	100.0	100.0
30	52.5	50.0	52.5	52.5	55.0	55.0	55.0	55.0	57.5	57.5	57.5	57.5	92.5	92.5	92.5	92.5	95.0	100.0	100.0	100.0
29	52.5	50.0	52.5	52.5	52.5	55.0	55.0	55.0	57.5	57.5	57.5	57.5	92.5	92.5	92.5	92.5	95.0	100.0	100.0	100.0
28	52.5	50.0	52.5	52.5	52.5	55.0	55.0	55.0	55.0	55.0	57.5	57.5	90.0	92.5	92.5	92.5	95.0	100.0	100.0	100.0
27	52.5	50.0	52.5	52.5	52.5	55.0	55.0	55.0	55.0	55.0	55.0	57.5	90.0	92.5	92.5	92.5	92.5	100.0	100.0	100.0
26	52.5	50.0	50.0	52.5	52.5	55.0	55.0	55.0	55.0	55.0	55.0	55.0	90.0	90.0	92.5	92.5	92.5	100.0	100.0	100.0
25	50.0	47.5	47.5	52.5	52.5	55.0	55.0	55.0	55.0	55.0	55.0	55.0	90.0	90.0	90.0	92.5	92.5	100.0	100.0	100.0
24	50.0	47.5	47.5	50.0	50.0	52.5	52.5	52.5	55.0	55.0	55.0	55.0	90.0	90.0	90.0	90.0	92.5	100.0	100.0	100.0
23	50.0	47.5	47.5	50.0	50.0	52.5	52.5	52.5	55.0	55.0	55.0	55.0	90.0	90.0	90.0	90.0	92.5	97.5	100.0	100.0
22	47.5	47.5	47.5	50.0	50.0	52.5	52.5	52.5	55.0	55.0	55.0	55.0	90.0	90.0	90.0	90.0	92.5	97.5	100.0	100.0
21	45.0	47.5	47.5	50.0	50.0	50.0	50.0	50.0	52.5	55.0	55.0	55.0	90.0	90.0	90.0	90.0	90.0	97.5	100.0	100.0
20	45.0	45.0	45.0	47.5	47.5	50.0	50.0	50.0	52.5	52.5	55.0	55.0	90.0	90.0	90.0	90.0	90.0	95.0	100.0	100.0
19	42.5	45.0	45.0	45.0	47.5	50.0	50.0	50.0	50.0	50.0	55.0	55.0	90.0	90.0	90.0	90.0	90.0	95.0	100.0	100.0
18	40.0	42.5	42.5	42.5	45.0	47.5	47.5	47.5	50.0	50.0	50.0	50.0	90.0	90.0	90.0	90.0	90.0	95.0	100.0	100.0
17	37.5	35.0	37.5	40.0	40.0	45.0	45.0	45.0	47.5	50.0	50.0	50.0	90.0	90.0	90.0	90.0	90.0	95.0	100.0	100.0
16	37.5	35.0	37.5	37.5	37.5	45.0	45.0	45.0	45.0	45.0	45.0	47.5	90.0	90.0	90.0	90.0	90.0	95.0	100.0	100.0
15	37.5	35.0	35.0	37.5	37.5	42.5	42.5	42.5	45.0	45.0	45.0	45.0	90.0	90.0	90.0	90.0	90.0	95.0	100.0	100.0
14	37.5	35.0	35.0	37.5	37.5	37.5	37.5	37.5	45.0	45.0	45.0	45.0	90.0	90.0	90.0	90.0	90.0	95.0	100.0	100.0
13	32.5	35.0	35.0	37.5	37.5	37.5	37.5	37.5	40.0	40.0	45.0	45.0	90.0	90.0	90.0	90.0	90.0	95.0	100.0	100.0
12	32.5	35.0	32.5	37.5	37.5	37.5	37.5	37.5	37.5	37.5	42.5	42.5	85.0	90.0	90.0	90.0	90.0	92.5	100.0	100.0
11	32.5	32.5	32.5	32.5	35.0	37.5	37.5	37.5	37.5	37.5	40.0	40.0	85.0	85.0	85.0	90.0	90.0	92.5	100.0	100.0
10	30.0	30.0	30.0	32.5	32.5	37.5	37.5	37.5	37.5	37.5	37.5	37.5	85.0	85.0	85.0	85.0	90.0	90.0	100.0	100.0
9	27.5	27.5	30.0	32.5	32.5	32.5	32.5	32.5	35.0	35.0	37.5	37.5	80.0	80.0	85.0	85.0	85.0	90.0	100.0	100.0
8	22.5	27.5	30.0	30.0	32.5	32.5	32.5	32.5	32.5	32.5	35.0	35.0	80.0	80.0	80.0	80.0	85.0	90.0	100.0	100.0
7	17.5	20.0	30.0	30.0	30.0	32.5	32.5	32.5	32.5	32.5	32.5	32.5	80.0	80.0	80.0	80.0	80.0	90.0	100.0	100.0
6	17.5	15.0	30.0	30.0	30.0	32.5	32.5	32.5	32.5	32.5	32.5	32.5	77.5	77.5	77.5	80.0	80.0	90.0	100.0	100.0
5	12.5	12.5	22.5	30.0	30.0	30.0	30.0	30.0	30.0	30.0	32.5	32.5	70.0	70.0	72.5	75.0	77.5	90.0	100.0	100.0
4	12.5	10.0	15.0	22.5	22.5	22.5	22.5	22.5	27.5	30.0	30.0	30.0	70.0	70.0	70.0	70.0	72.5	85.0	100.0	100.0
3	5.0	7.5	15.0	15.0	15.0	20.0	20.0	20.0	22.5	22.5	22.5	22.5	60.0	60.0	60.0	60.0	67.5	70.0	80.0	100.0	100.0
2	0	0	2.5	5.0	5.0	7.5	7.5	7.5	10.0	10.0	17.5	17.5	50.0	50.0	50.0	50.0	50.0	72.5	100.0	100.0
1	0	0	0	0	0	0	0	0	0	0	2.5	2.5	30.0	32.5	32.5	32.5	37.5	52.5	100.0	100.0

5.0 10.0 15.0 20.0 25.0 30.0 35.0 40.0 45.0 50.0 55.0 60.0 65.0 70.0 75.0 80.0 85.0 90.0 95.0 100.0

CUMULATIVE FUEL MOISTURE LEVEL

THE NUMBER OF PLOTS USED 40

Table 16 : Scorch Height Distributions

SCORCH HEIGHT DISTRIBUTIONS FOR STANDS BETWEEN 0 AND 55 YEARS OF AGE

CUMULATIVE SCORCH HEIGHT DISTIBUTIONS VS FIVE PER CENT CUMULATIVE

INCREMENTS OF FUEL MOISTURE FOR EACH FUEL CLASS

SCORCH HEIGHT (TRUNCATED) (METERS)	5.0	10.0	15.0	20.0	25.0	30.0	35.0	40.0	45.0	50.0	55.0	60.0	65.0	70.0	75.0	80.0	85.0	90.0	95.0	100.0
35	100	100	100	100	100	100	100	100	100	100	100	100	100	100						
34																				
33															100					
32	75															100				
31																				
30																				
29																				
28																	100			
27																				
26																				
25																				
24																				
23																				
22																				
21																				
20																				
19																				
18																				
17																				
16																				
15																				
14		50																100		
13																				
12	50																			
11																				
10			50																	
9				50																
8					50	50	50	50												
7									50	50	50	50	75							
6	25	25												75	75	75				
5																	75			
4													50	50	50	50				
3			25	25	25	25	25	25									50			
2									25	25	25	25	25	25	25	25	25	75		
1																		25	100	100

CUMULATIVE MOISTURE LEVEL

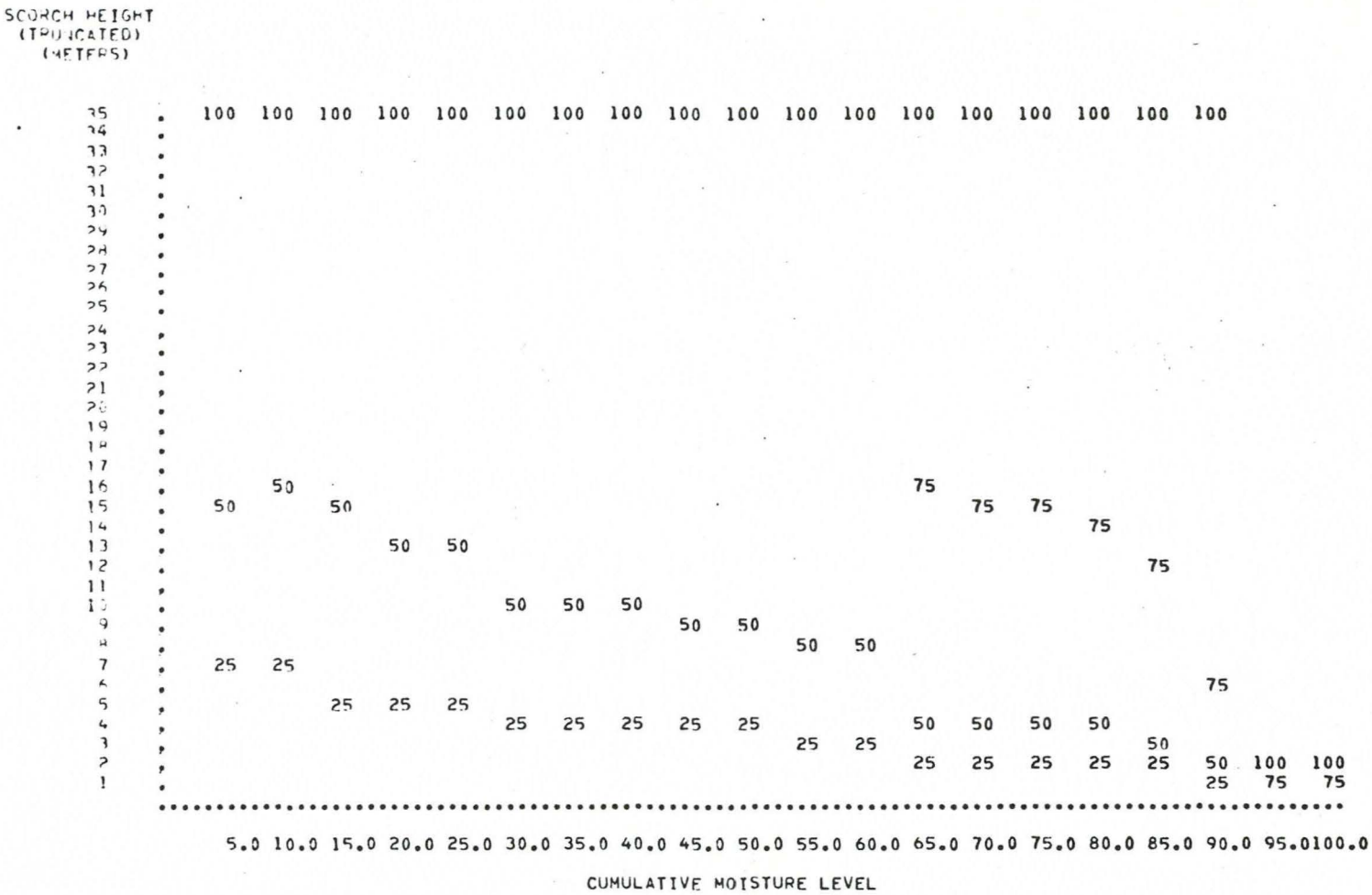
THE NUMBER OF PLOTS USED 13

Table 17 : Scorch Height Distributions

SCORCH HEIGHT DISTRIBUTIONS FOR STANDS BETWEEN 55 AND 105 YEARS OF AGE

CUMULATIVE SCORCH HEIGHT DISTIBUTIONS VS FIVE PER CENT CUMULATIVE

INCREMENTS OF FUEL MOISTURE FOR EACH FUEL CLASS


SCORCH HEIGHT (TRUNCATED) (METERS)
35 34 33 32 31 30 29 28 27 26 25 24 23 22 21 20 19 18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1
100 100 100 100 100 100 100 100 100 100 100 100 100 100 100 100 100 100 100
50 50 50

SCORCH HEIGHT DISTRIBUTIONS FOR STANDS BETWEEN 105 AND 155 YEARS OF AGE

CUMULATIVE SCORCH HEIGHT DISTIBUTIONS VS FIVE PER CENT CUMULATIVE

INCREMENTS OF FUEL MOISTURE FOR EACH FUEL CLASS

SCORCH HEIGHT (TRUNCATED) (METERS)	5.0	10.0	15.0	20.0	25.0	30.0	35.0	40.0	45.0	50.0	55.0	60.0	65.0	70.0	75.0	80.0	85.0	90.0	95.0	100.0
35	100	100	100	100	100	100	100	100	100	100	100	100								
34																				
33	75																			
32		75	75																	
31				75	75															
30																				
29																				
28																				
27						75	75	75												
26																				
25									75											
24										75										
23											75	75								
22																				
21																				
20																				
19																				
18	50	50																		
17																				
16																				
15																				
14																				
13			50										100							
12				50	50									100	100					
11																100				
10						50	50	50									100			
9		25							50	50										
8	25										50	50								
7																				
6			25																	
5				25	25													100		
4						25	25	25					75	75	75	75				
3									25	25	25	25	50	50	50	50	75			
2													25	25	25	25	25	75		
1																		50	100	100

CUMULATIVE MOISTURE LEVEL

THE NUMBER OF PLOTS USED 43

Table 19 : Scorch Height Distributions

SCORCH HEIGHT DISTRIBUTIONS FOR STANDS BETWEEN 155 AND 300 YEARS OF AGE

CUMULATIVE SCORCH HEIGHT DISTIBUTIONS VS FIVE PER CENT CUMULATIVE

INCREMENTS OF FUEL MOISTURE FOR EACH FUEL CLASS

SCORCH HEIGHT
(TRUNCATED)
(METERS)

	5.0	10.0	15.0	20.0	25.0	30.0	35.0	40.0	45.0	50.0	55.0	60.0	65.0	70.0	75.0	80.0	85.0	90.0	95.0	100.0
35	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100			
34																				
33																				
32																				
31																				
30																				
29																				
28																				
27																				
26		50	50																	
25																				
24																		100		
23	50																			
22																				
21				50	50															
20																				
19						50	50	50												
18									50											
17										50	50	50								
16																				
15																				
14																				
13																				
12																				
11																				
10																				
9	25																			
8		25																		
7																				
6			25										75	75	75					
5				25	25	25	25	25								75	75			
4									25	25	25	25								
3																		75		
2													50	50	50	50	50			
1													25	25	25	25	25	50	100	100

CUMULATIVE MOISTURE LEVEL

THE NUMBER OF PLOTS USED 41

Table 20 : Scorch Height Distributions

APPENDIX B

DISTRIBUTIONS OF FUEL CHARACTERISTICS : WEST LAKES DISTRICT, GLACIER NATIONAL PARK

The histograms of fuel array characteristics in this appendix are taken from Bevins and Jeske (1976), and were used to obtain the sample system output reproduced in Appendix A.

Currently there are few known quantified patterns that characterize naturally occurring wildland fuels. This is a brief summary of a preliminary analysis to stratify natural fuels along two environmental gradients. It is an attempt to illustrate fuel loading distributions, as well as eventually provide possible numerical input parameters to various fire behavior models for characterized sites occurring at particular points within a complex gradient matrix. The data were collected in Glacier National Park during the summer of 1975 by three Gradient Modeling, Inc. field crews using an adapted version of the planar intersect method (Brown, 1974) for use with the Glacier BURN model.

The four-hundred-thirty-one data points were categorized as to their positions within a "six dimensional gradient hyperspace" (Kessell, 1974). As six gradients and four disturbance categories define a staggering number of land form/vegetational relationships, and fuels tend to exhibit a high degree of natural variability, it is easy to realize that the data base was too sparse to perform many meaningful statistical comparisons. The investigators defined two principal gradients most affecting fuel distributions; Primary succession/Cover type (spatial--for inter-stand comparison) and Secondary succession/Years since burn (temporal). It is suspected that fuel distributions can be further stratified into types that may be associated with forested stands that characteristically occur on mesic as opposed to more xeric sites, but this has yet to be investigated.

After completing the rather involved process of editing the data base exchanged from the IBM to CDC systems, the Glacier fuel data was converted by a computer program, FUELSUM, into a standard format on to tape number 1192

on the CDC system. This created an easily accessible format for the raw data to be used in further analyses and yielded a printed output for all 431 plots which could be used for on hand reference. Analyses were performed by two main programs and three subroutines. The first program stratified loadings for eight fuel types, (litter, grass and forbs, one hour, ten hour, 100 hour, 100 plus hour, average weight shrub foliage, and average weight shrub branchwood) into nine primary succession/cover type categories (glacier, rock, talus, talus meadow, meadow, prairie, shrub, Krummholz, and upright forest). Mean loading values for all fuels were calculated and plotted on bar diagrams to illustrate differences in fuel distributions between discrete primary succession/cover type categories. Categories were differentiated by soil/site development. The data points for each respective fuel type within the upright forest cover type were then put into frequency distributions. Histograms were made from these distributions, with characteristic size loading intervals for each fuel type.

Forest fuels were organized into discrete units along a time continuum representing secondary succession/years since burn. Three temporal series were run with ten, twenty, and fifty year intervals respectively. The ten year series was eliminated because field determination of stand age was of limiting accuracy and there were too few data points within each age interval. In the 20 and 50 year series, at each stand age interval the data were ordered and put into a histogram using the same load intervals derived from the original histograms of the respective fuel types for all forested stands. Mean, median, probability of a particular loadings occurance at an interval, and cumulative probability of occurrance, were calculated for each fuel type

at a particular stand age. Cumulative probability was hand plotted and the shapes of the curves approximated Poisson distributions (untested to date). Tables were made of mean and median loadings for the 20 and 50 year interval series and medians were graphically depicted on bar diagrams.

Analysis of the information presented in the tables and bar diagrams is currently in preperation for a joint paper to be delivered at the American Institute of Biological Sciences meeting later this year (Bevins and Jeske, 1976).

TABLE I

MEAN FUEL LOADINGS* BY YEARS SINCE BURN

50 YEAR SERIES

	Upper Limits of Years Since Burn Interval				
FUEL TYPE	10	55	105	155	>155
Litter	1.90	2.44	2.55	3.29	2.51
Grass & Forbs	.84	.39	.43	.40	.47
1 Hour	.72	1.11	1.05	1.17	1.11
10 Hour	2.74	1.72	1.54	1.79	2.20
100 Hour	7.37	7.06	3.89	4.26	3.59
100+Hour	40.00	22.42	21.35	34.00	53,89
Shrub Foliage	2.20	1.54	1.70	.59	.73
Shrub Branchwood	6.64	9.58	7.21	1.62	3.53

* Loadings in Metric Ton/Hectare

TABLE II

MEDIAN FUEL LOADINGS BY YEARS SINCE BURN

50 YEAR SERIES

FUEL TYPE	Upper Limits of Years Since Burn Interval 10	55	105	155	>155
Litter	.67	2.18	2.20	2.74	2.15
Grass & Forbs	.48	.25	.30	.24	.21
1 Hour	.42	1.06	.73	.97	.97
10 Hour	2.77	1.34	1.17	1.65	1.62
100 Hour	6.02	3.38	1.70	3.37	1.70
100+Hour	27.80	11.97	11.20	21.09	37.02
Shrub Foliage	1.13	.72	.38	.39	.19
Shrub Branchwood	3.76	2.24	1.22	1.24	.62

*Loadings in Metric Ton/Hectare

TABLE III

MEDIAN FUEL LOADINGS BY YEARS SINCE BURN

20 YEAR SERIES

FUEL TYPE	Upper Limits of Years Since Burn Intervals								
	10	44	69	89	109	129	149	169	>170
Litter	.67	2.24	2.00	2.08	2.56	2.74	3.97	2.30	2.15
Grass & Forbs	.48	.45	.33	.30	.34	.24	.17	.36	.21
1 Hour	.42	1.05	1.06	.72	.88	.96	.86	1.02	1.02
10 Hour	2.77	1.18	1.62	1.18	1.24	1.35	1.65	2.19	1.70
100 Hour	6.02	3.37	3.38	1.69	3.51	3.43	5.98	1.86	1.70
100+Hour	27.80	32.51	8.93	15.51	9.65	15.00	29.86	29.49	46.71
Shrub Foliage	1.13	.74	.40	.41	.42	.44	.31	.44	.20
Shrub Branchwood	3.76	5.39	1.35	1.75	1.43	1.60	1.08	1.24	.68

*Loadings in Metric Tons/Hectare

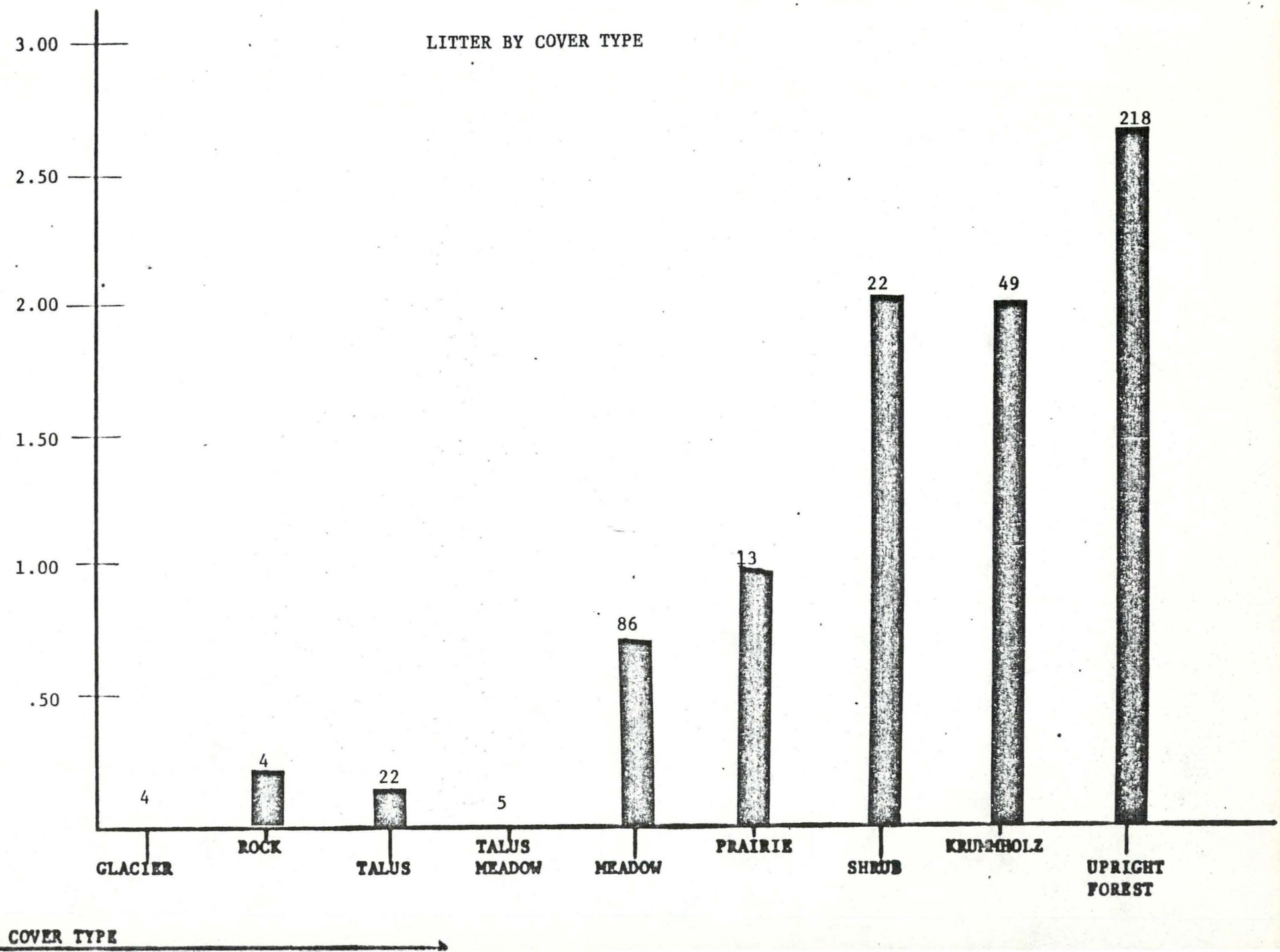
TABLE IV

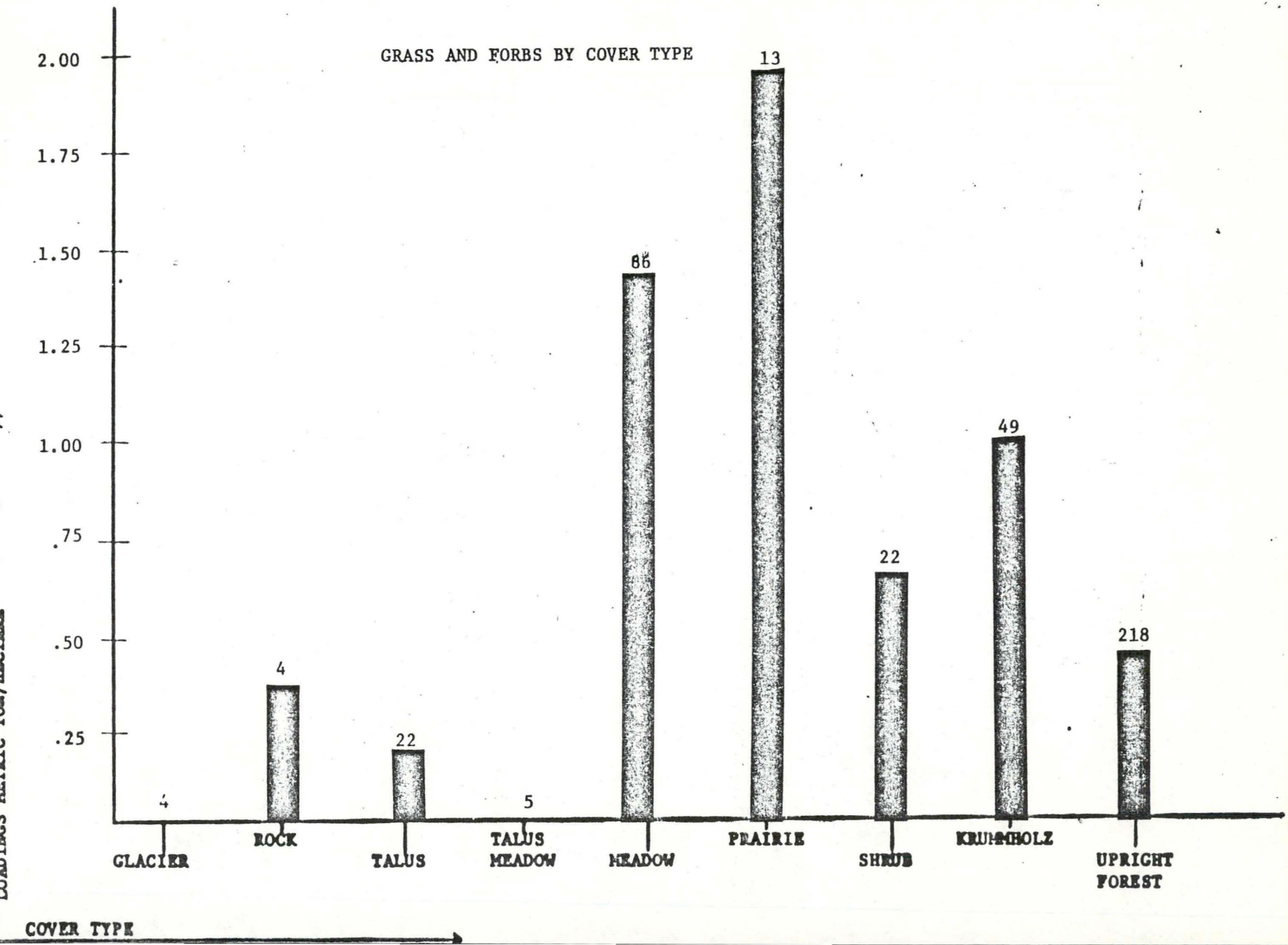
MEAN FUEL LOADINGS* BY YEARS SINCE BURN

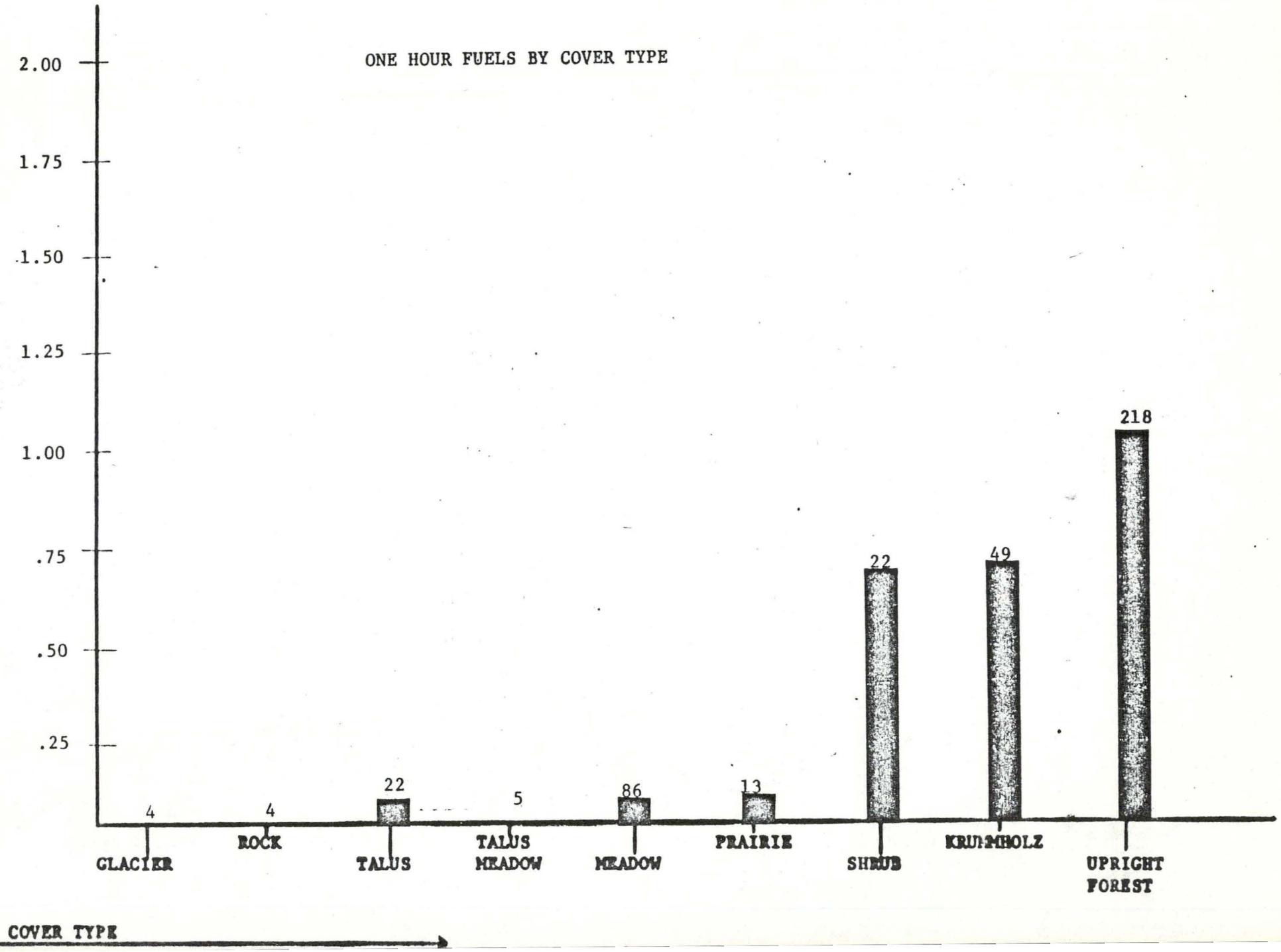
20 YEAR SERIES

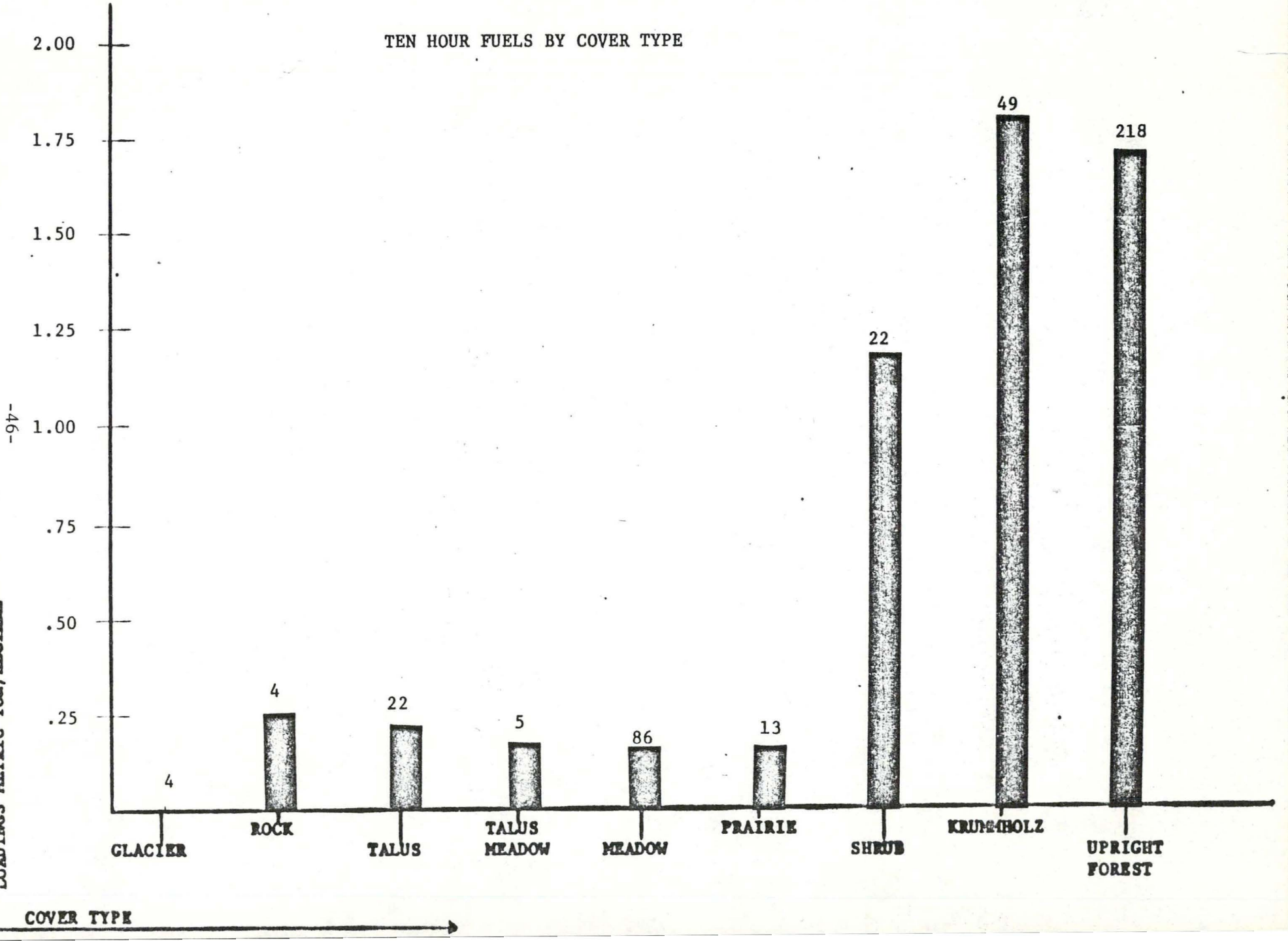
FUEL TYPE	Upper Limits of Years Since Burn Intervals								
	10	44	69	89	109	129	149	169	>170
Litter	1.90	2.38	2.43	2.36	3.36	3.12	4.10	3.09	2.54
Grass & Forbs	.84	.41	.44	.43	.37	.42	.19	.58	.43
1 Hour	.72	.90	1.13	1.10	.93	1.12	.94	1.26	1.12
10 Hour	2.74	1.15	1.81	1.56	1.55	1.48	1.51	2.37	2.23
100 Hour	7.37	4.16	7.52	4.17	3.12	4.66	6.09	3.68	3.30
100+Hour	40.00	36.50	15.86	23.84	15.71	30.22	42.75	35.70	55.69
Shrub Foliage	2.20	1.34	1.47	2.01	.70	.59	.37	.75	.70
Shrub Branchwood	6.64	7.21	9.48	7.99	5.08	1.72	1.13	1.93	3.54

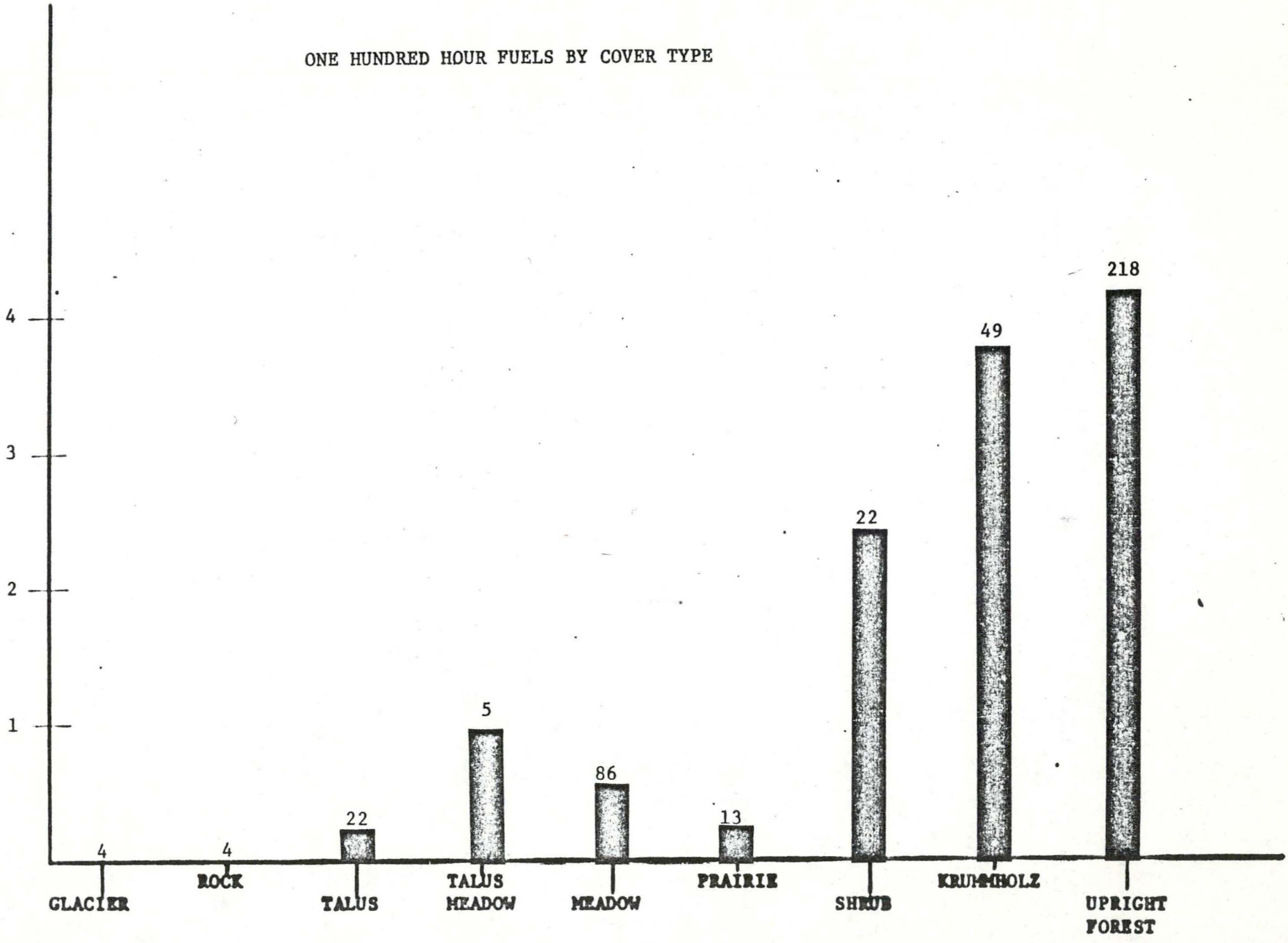
* Loadings in Metric Tons/Hectare

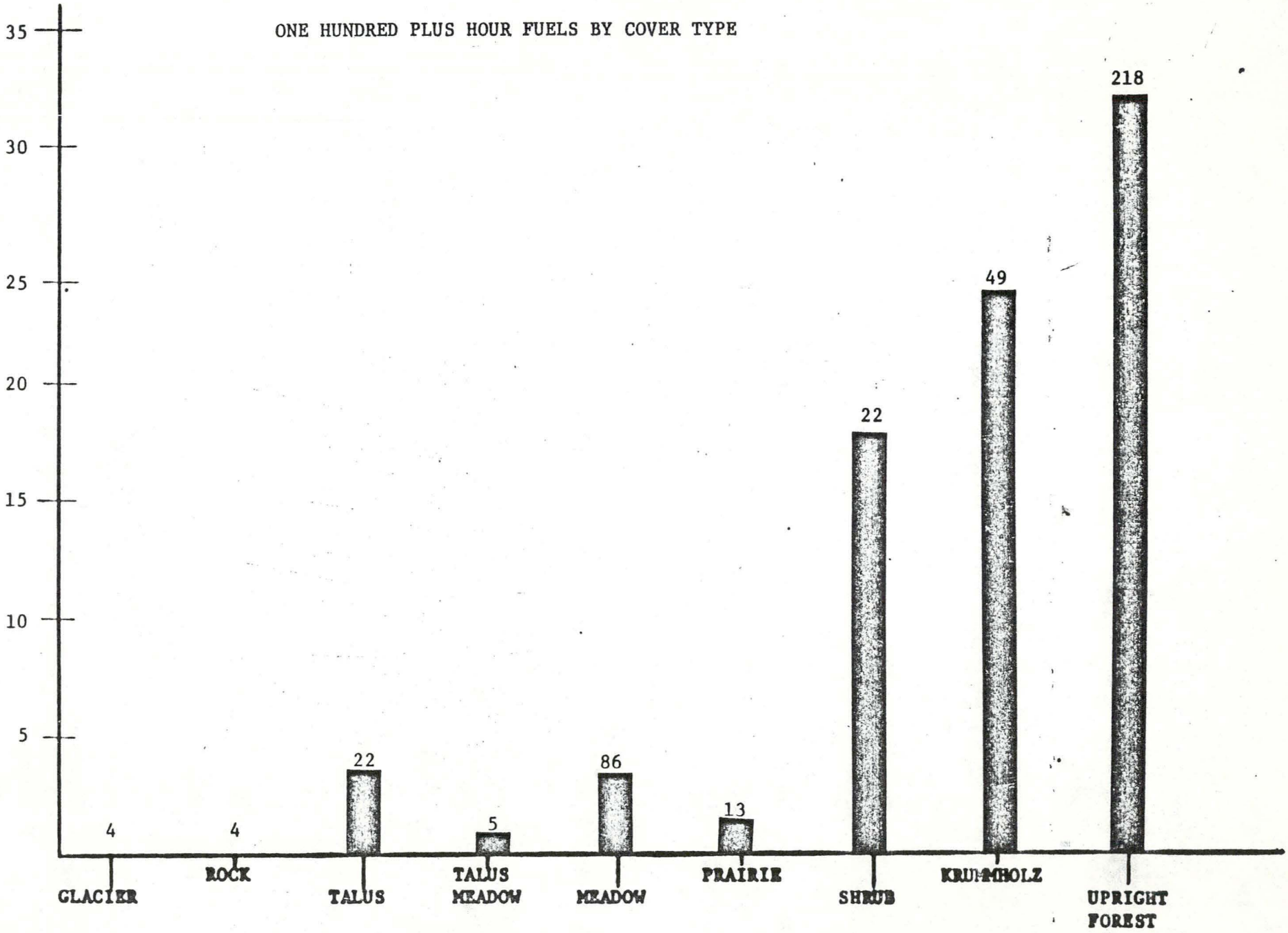

LITTER BY COVER TYPE
3.00
2.50
2.00
1.50
1.00
.50
LOADINGS METRIC TON/HECTARE
COVER TYPE
4
4
22
5
86
13
22
49
218
GLACIER
ROCK
TALUS
TALUS MEADOW
MEADOW
PRAIRIE
SHRUB
KRUMMHOLZ
UPRIGHT FOREST

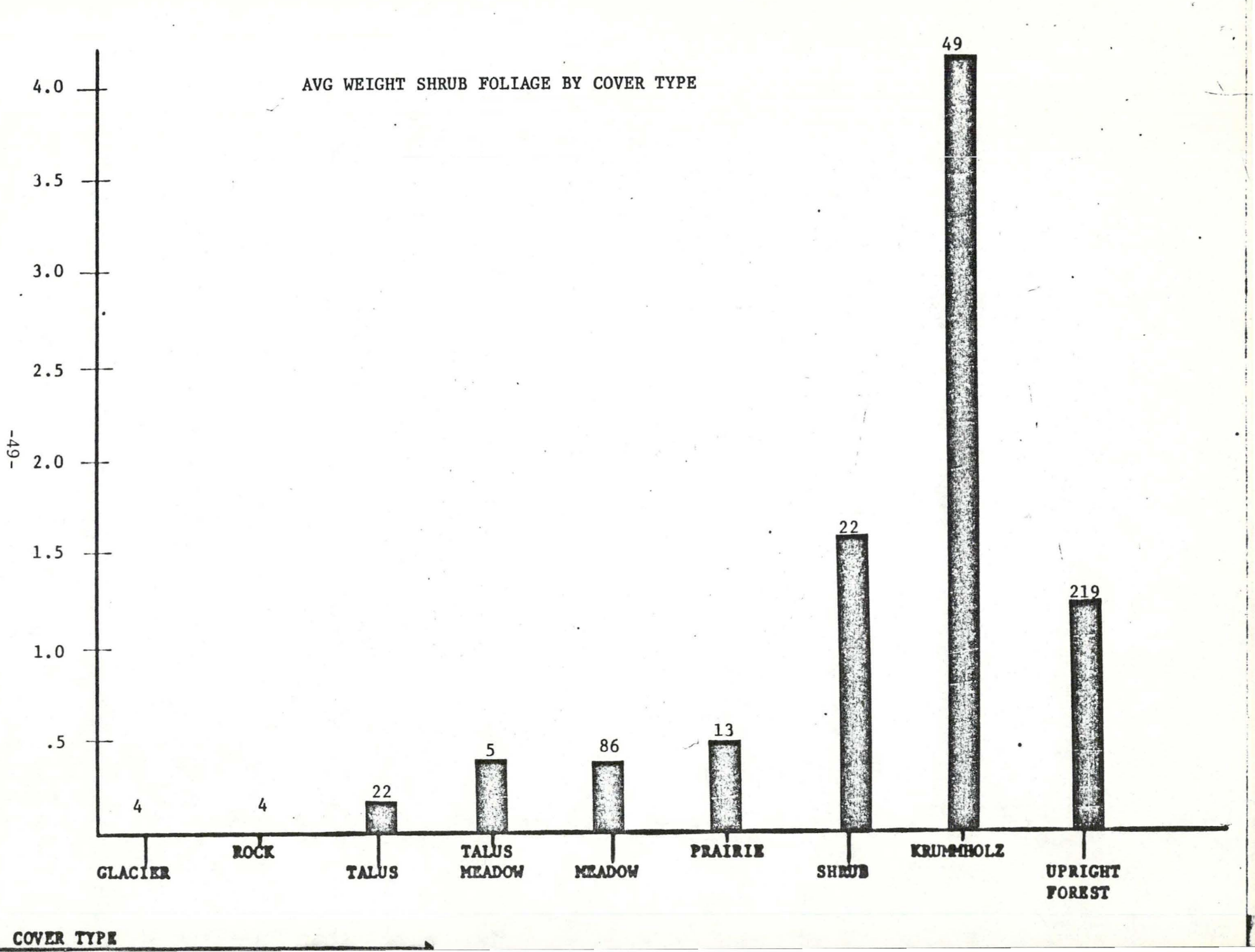

GRASS AND FORBS BY COVER TYPE
2.00
1.75
1.50
1.25
1.00
.75
.50
.25
4
4
22
5
86
13
22
49
218
GLACIER
ROCK
TALUS
TALUS MEADOW
MEADOW
PRAIRIE
SHRUB
KRUMMHOLZ
UPRIGHT FOREST
COVER TYPE

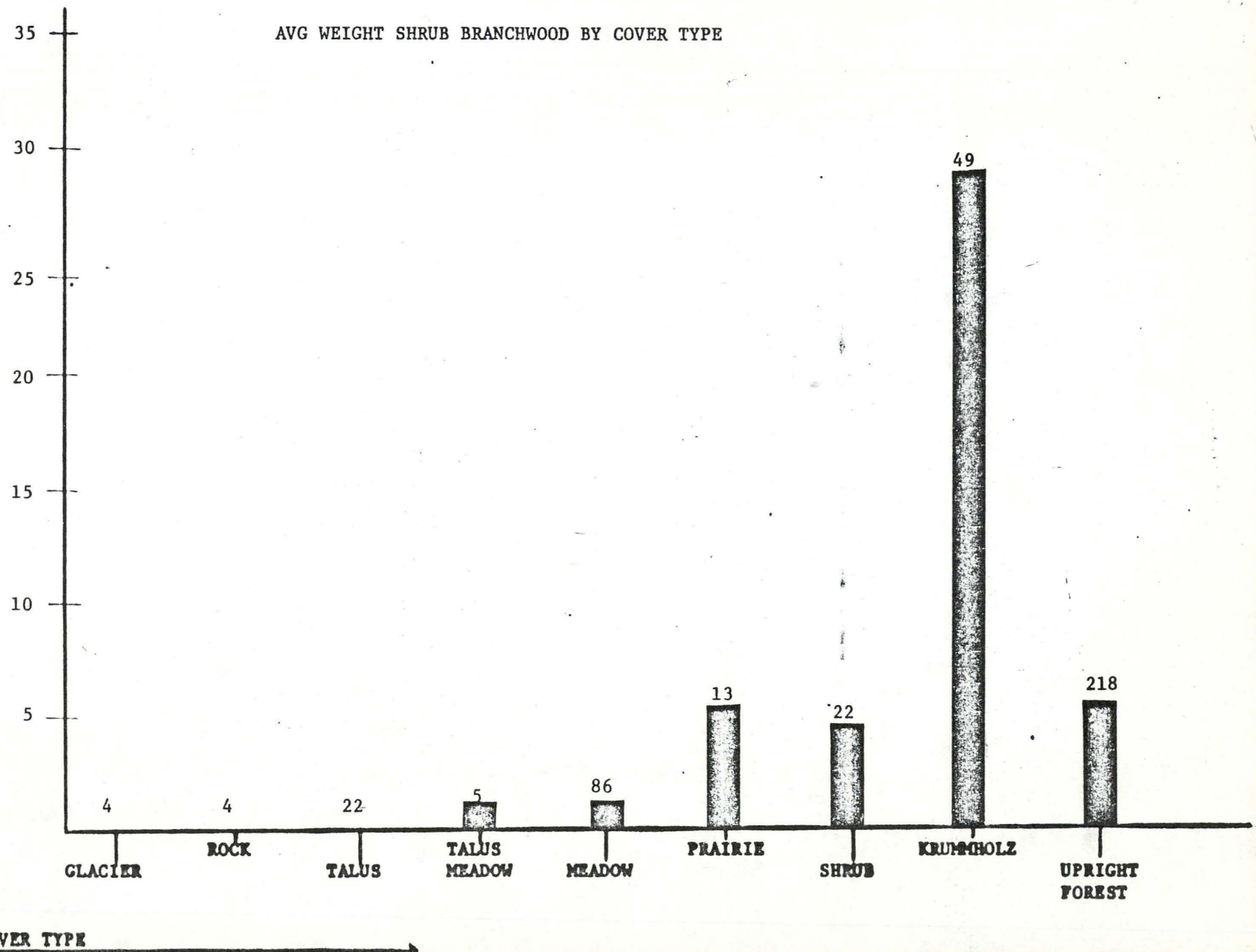

ONE HOUR FUELS BY COVER TYPE
2.00
1.75
1.50
1.25
1.00
.75
.50
.25
4
4
22
5
86
13
22
49
218
GLACIER
ROCK
TALUS
TALUS MEADOW
MEADOW
PRAIRIE
SHRUB
KRUMMHOLZ
UPRIGHT FOREST
COVER TYPE


TEN HOUR FUELS BY COVER TYPE
2.00
1.75
1.50
1.25
1.00
.75
.50
.25
4
4
22
5
86
13
22
49
218
GLACIER
ROCK
TALUS
TALUS MEADOW
MEADOW
PRAIRIE
SHRUB
KRUMMHOLZ
UPRIGHT FOREST
COVER TYPE

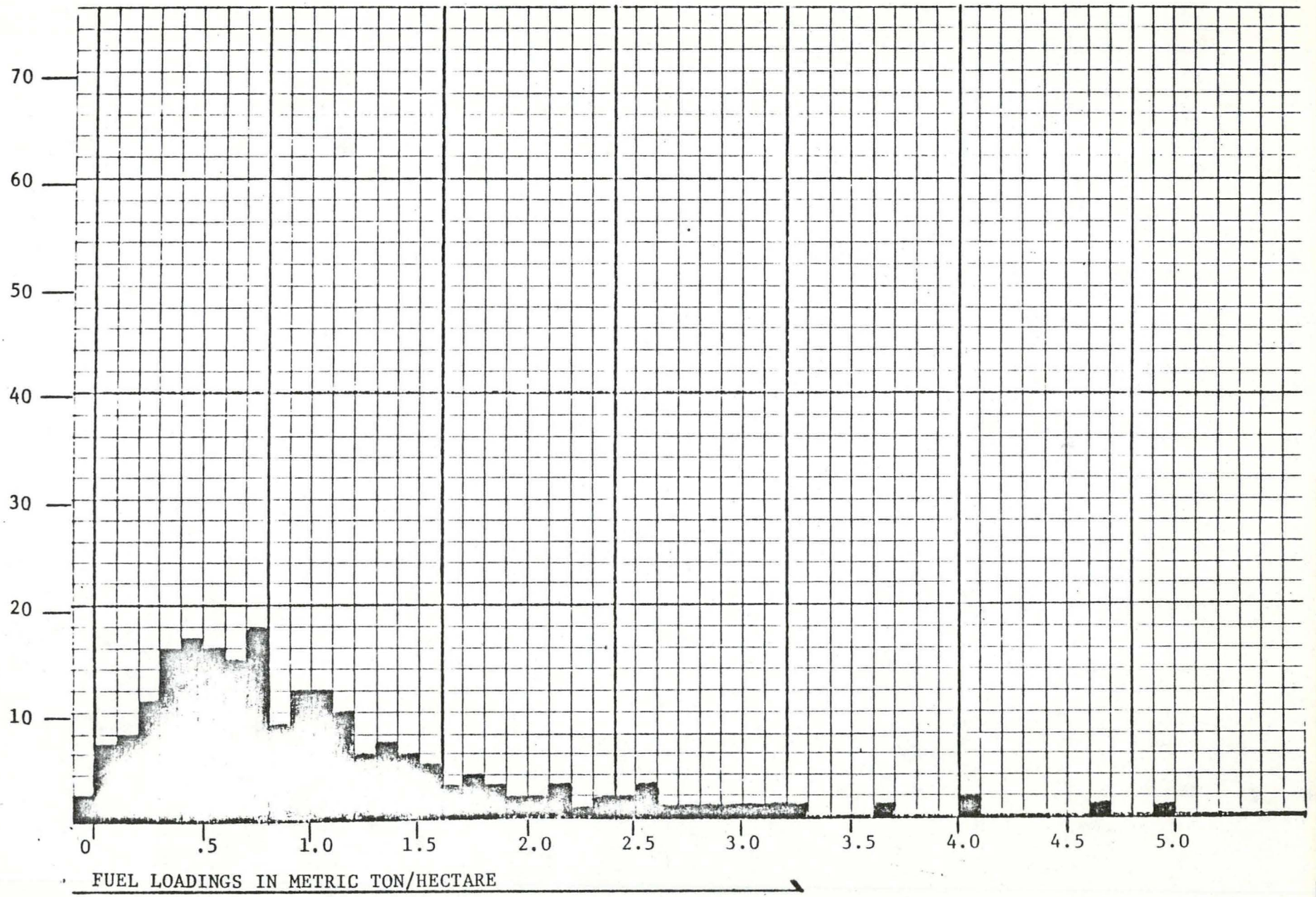

ONE HUNDRED HOUR FUELS BY COVER TYPE
4
3
2
1
4
4
22
5
86
13
22
49
218
GLACIER
ROCK
TALUS
TALUS MEADOW
MEADOW
PRAIRIE
SHRUB
KRUMMHOLZ
UPRIGHT FOREST
COVER TYPE


ONE HUNDRED PLUS HOUR FUELS BY COVER TYPE
35
30
25
20
15
10
5
4
4
22
5
86
13
22
49
218
GLACIER
ROCK
TALUS
TALUS MEADOW
MEADOW
PRAIRIE
SHRUB
KRUMMHOLZ
UPRIGHT FOREST
COVER TYPE

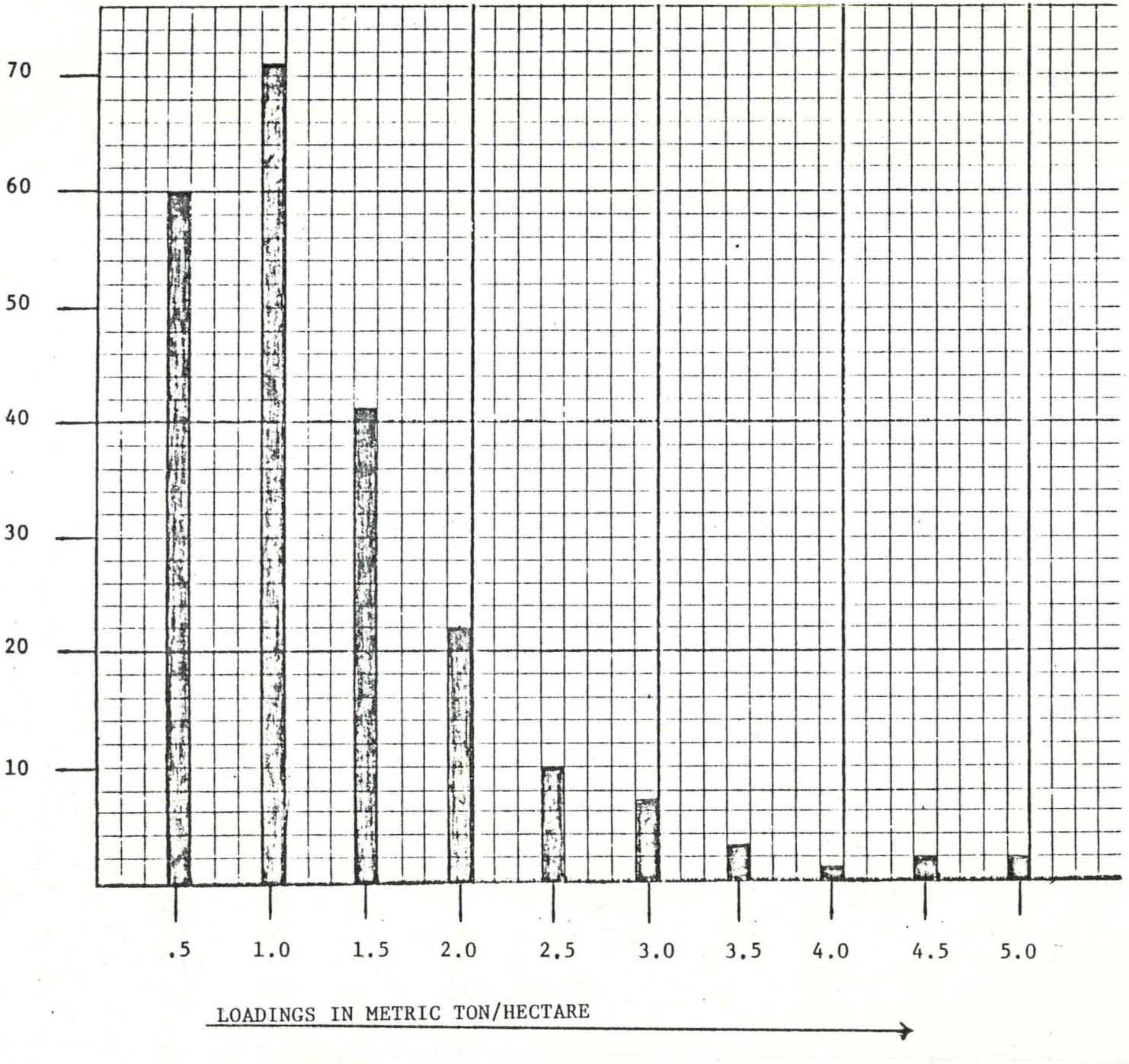

AVG WEIGHT SHRUB FOLIAGE BY COVER TYPE
4.0
3.5
3.0
2.5
2.0
1.5
1.0
.5
4
4
22
5
86
13
22
49
219
GLACIER
ROCK
TALUS
TALUS MEADOW
MEADOW
PRAIRIE
SHRUB
KRUMMHOLZ
UPRIGHT FOREST
COVER TYPE


AVG WEIGHT SHRUB BRANCHWOOD BY COVER TYPE
35
30
25
20
15
10
5
4
4
22
5
86
13
22
49
218
GLACIER
ROCK
TALUS
TALUS MEADOW
MEADOW
PRAIRIE
SHRUB
KRUMMHOLZ
UPRIGHT FOREST
COVER TYPE

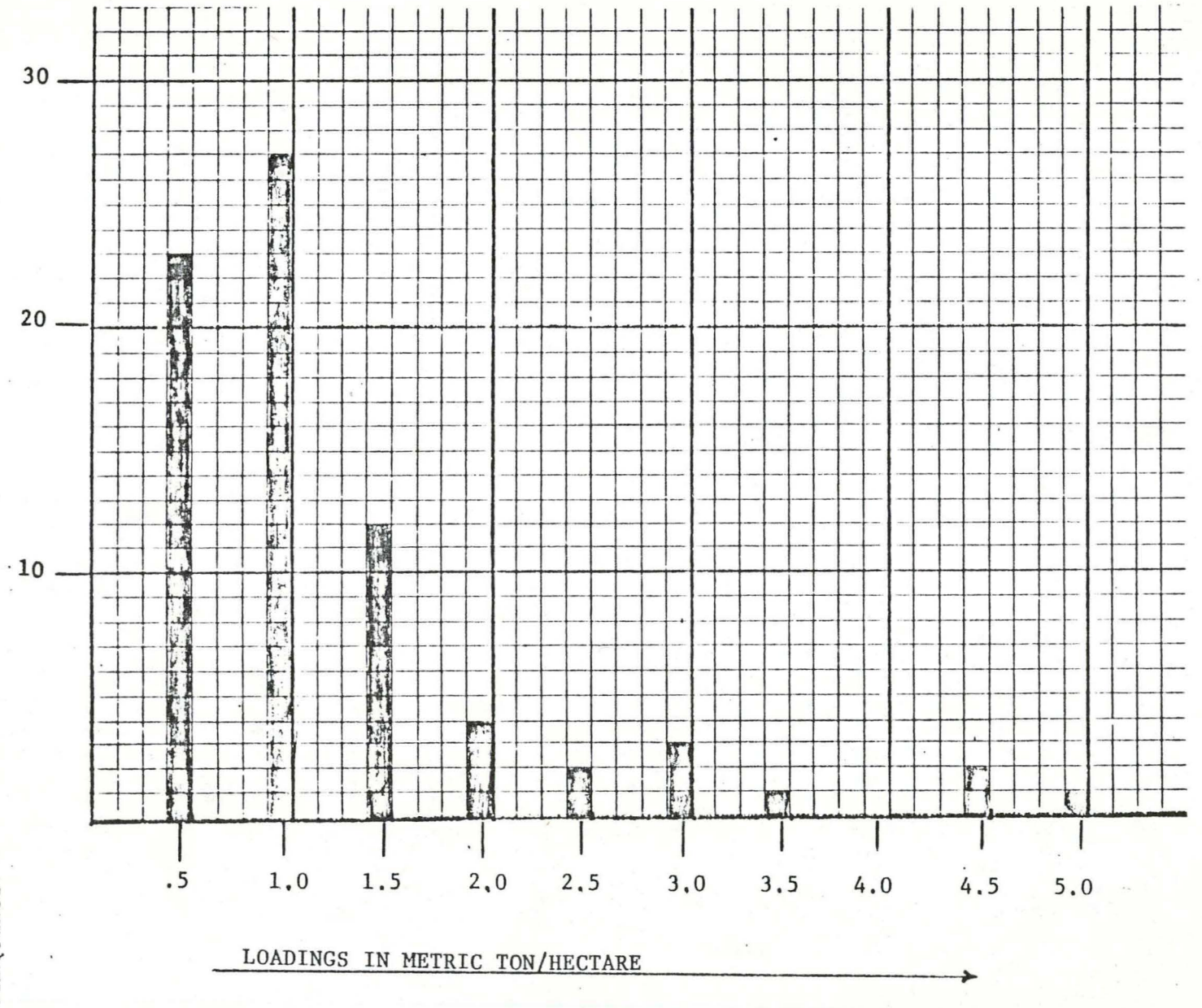
FREQUENCY DISTRIBUTION FOR ALL FOREST ONE HOUR FUELS



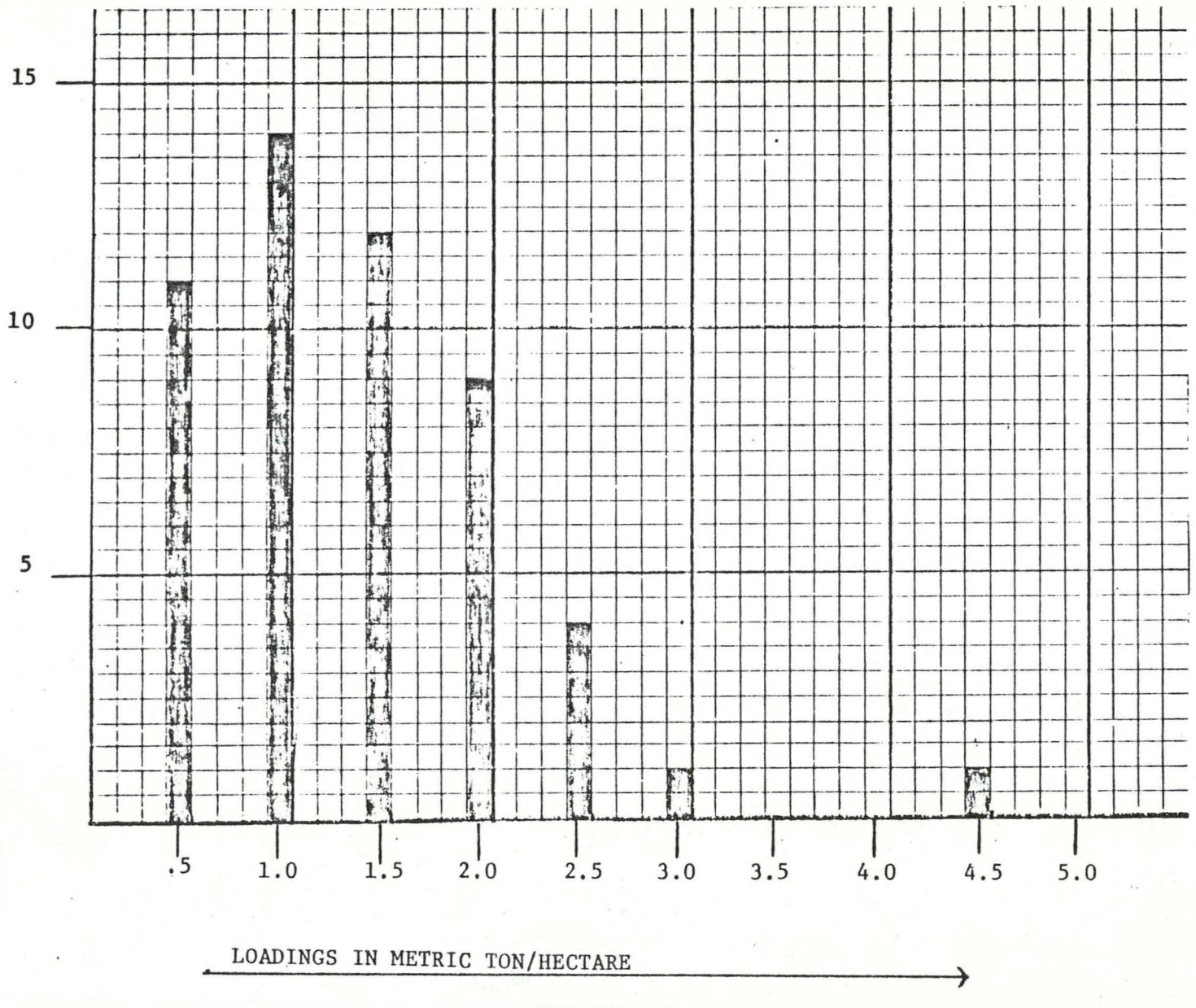
HISTOGRAM FOR ALL FOREST ONE HOUR FUELS



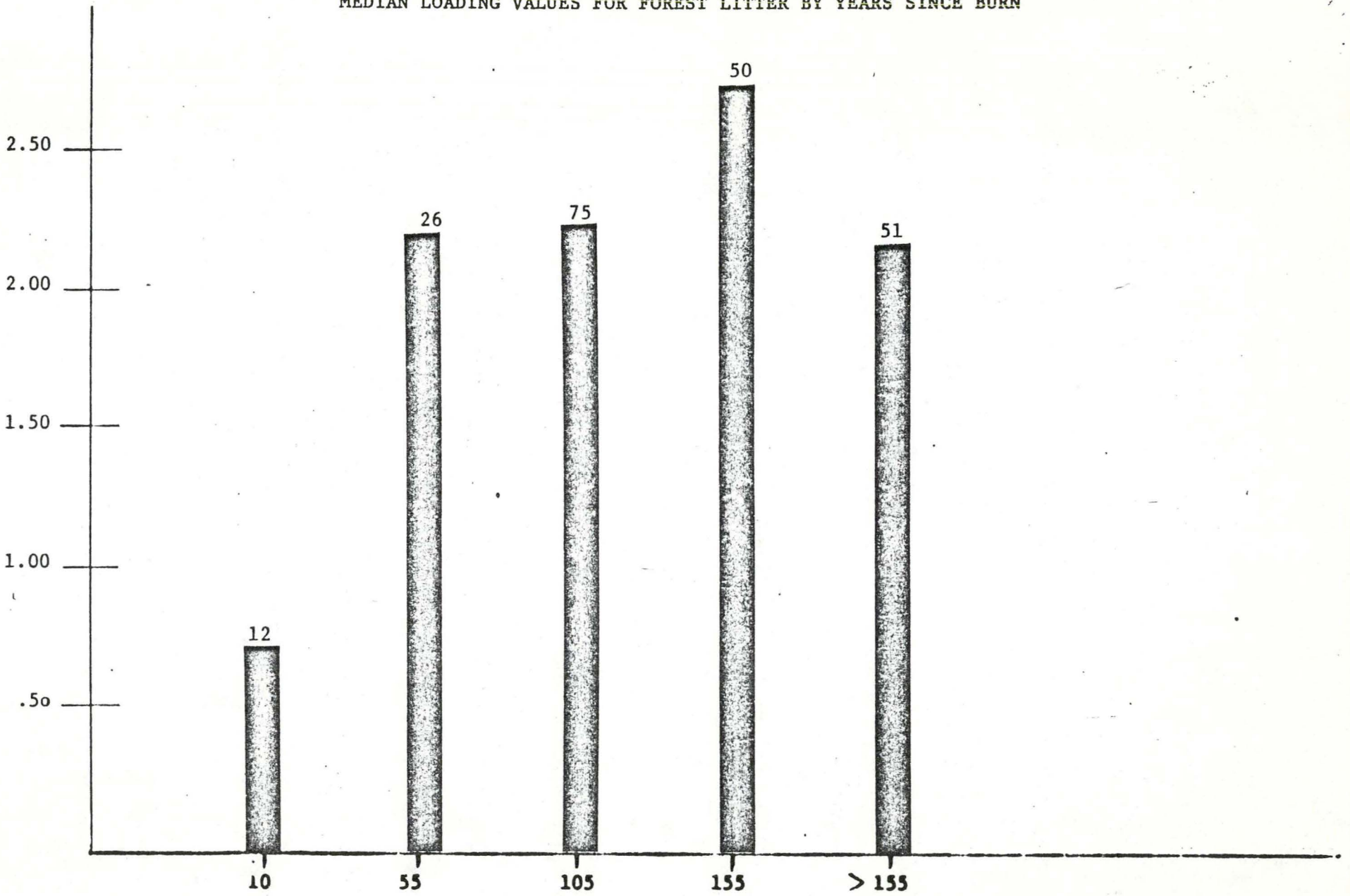
HISTOGRAM FOR FOREST ONE HOUR FUELS
56-105 YEARS SINCE BURN



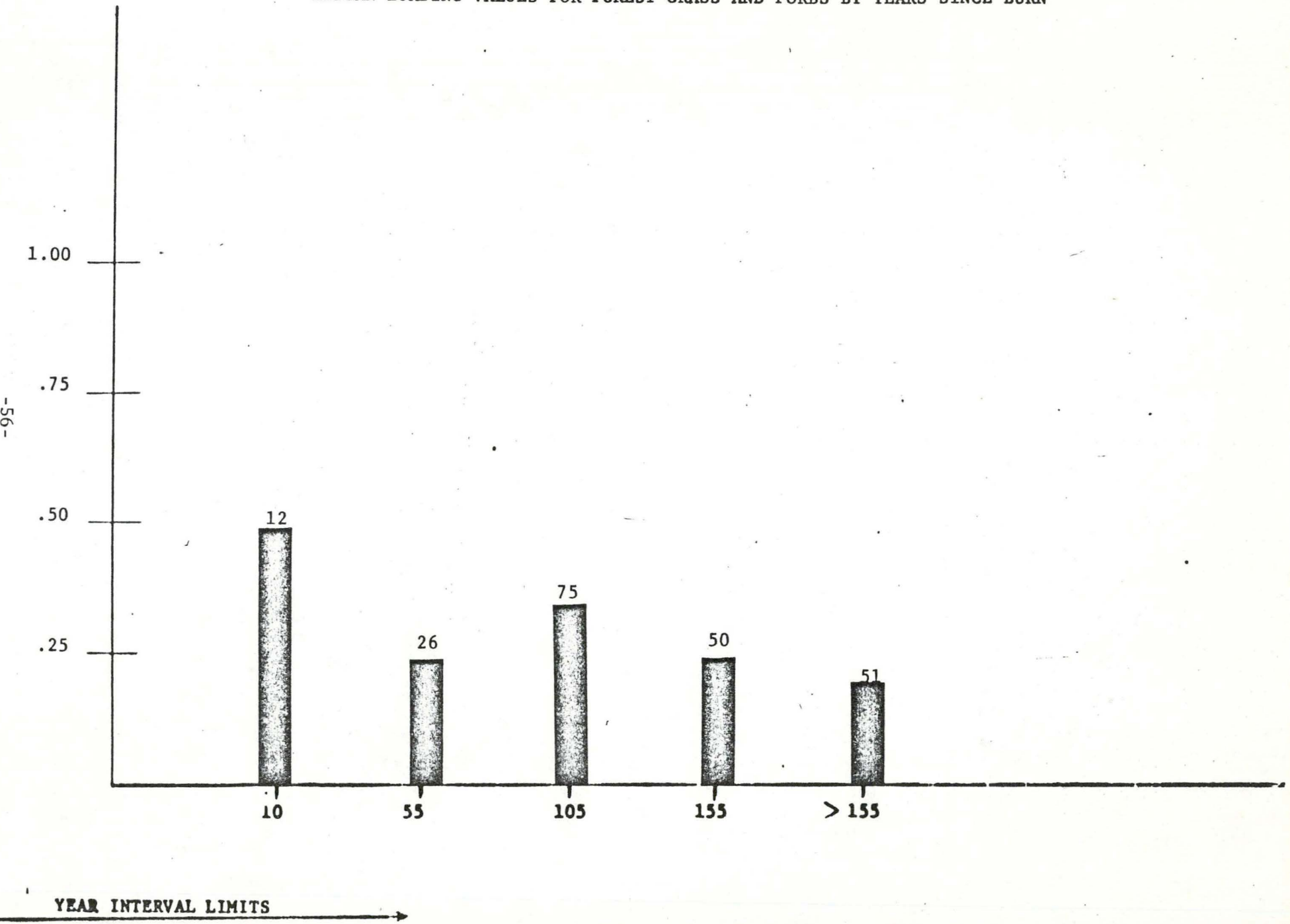
HISTOGRAM FOR FOREST ONE HOUR FUELS
OVER 155 YEARS SINCE BURN



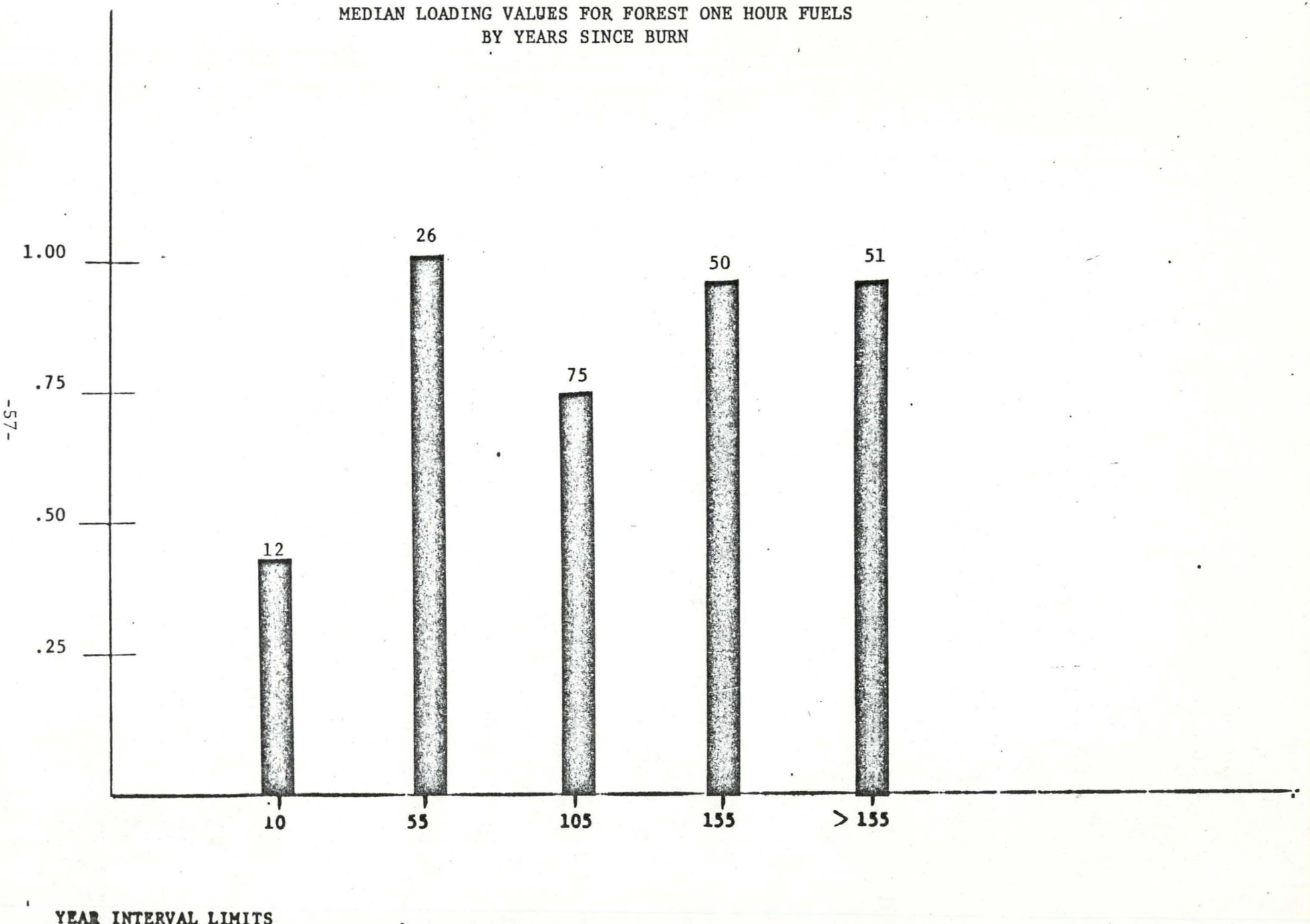
MEDIAN LOADING VALUES FOR FOREST LITTER BY YEARS SINCE BURN



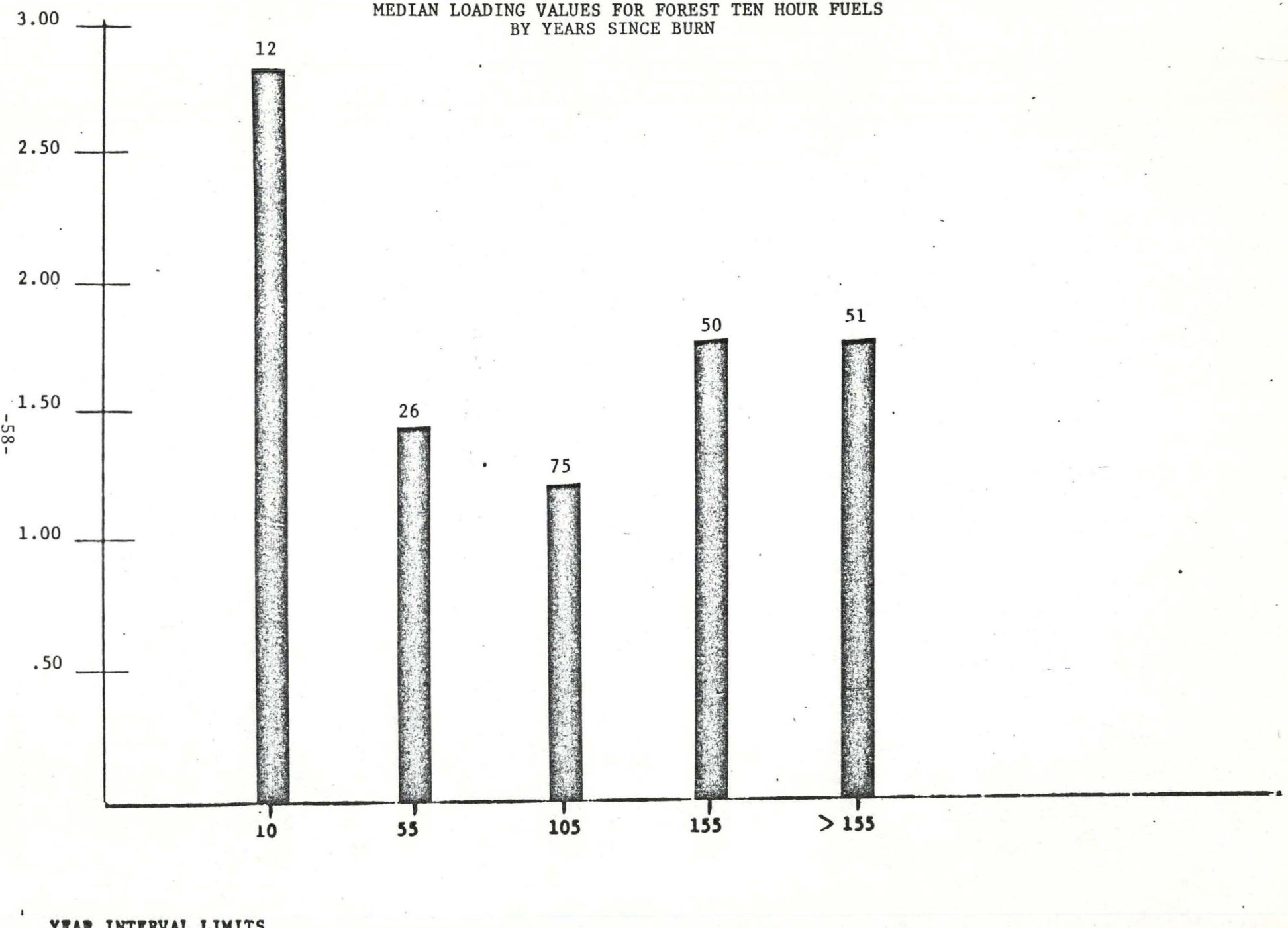
MEDIAN LOADING VALUES FOR FOREST GRASS AND FORBS BY YEARS SINCE BURN



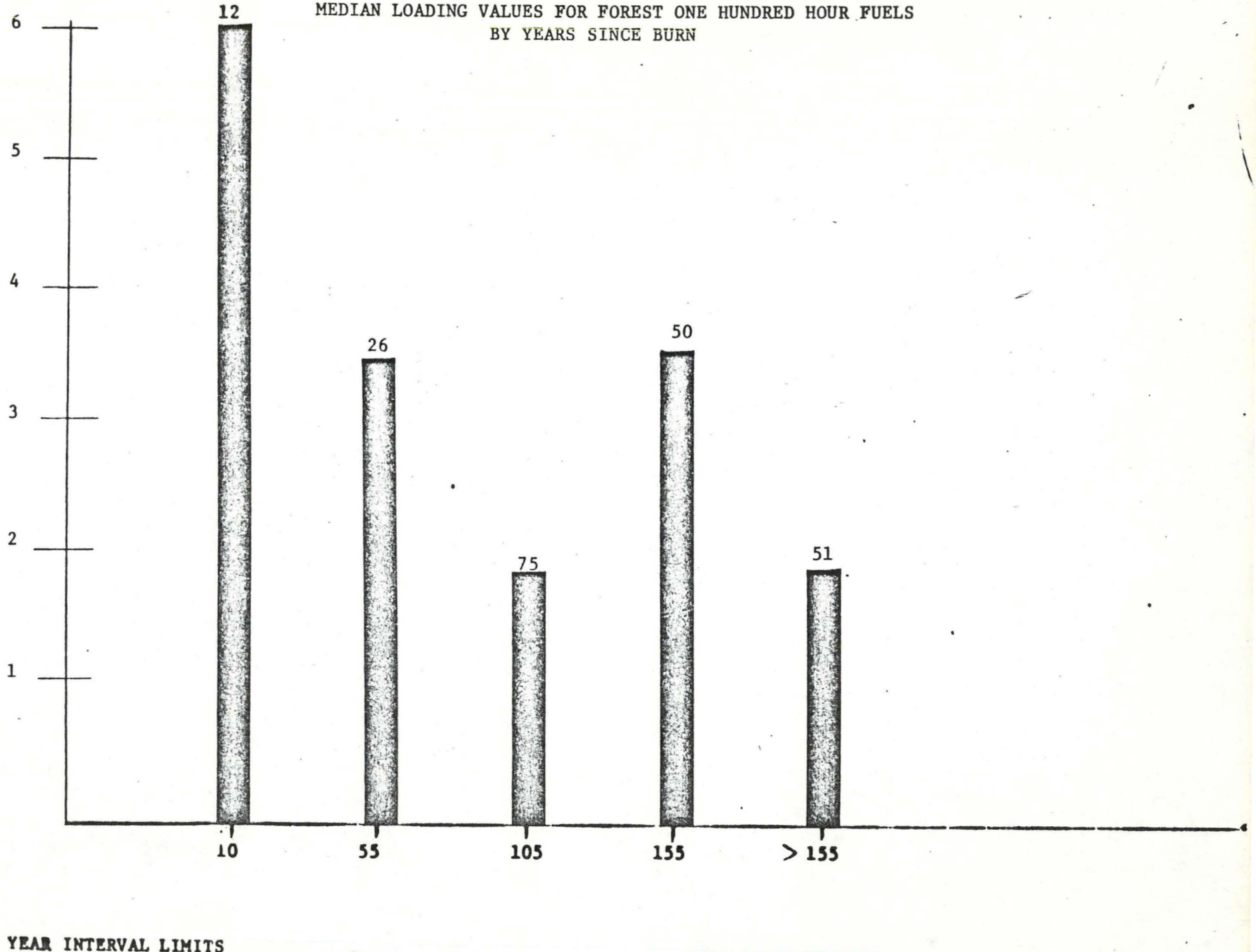
MEDIAN LOADING VALUES FOR FOREST ONE HOUR FUELS
BY YEARS SINCE BURN



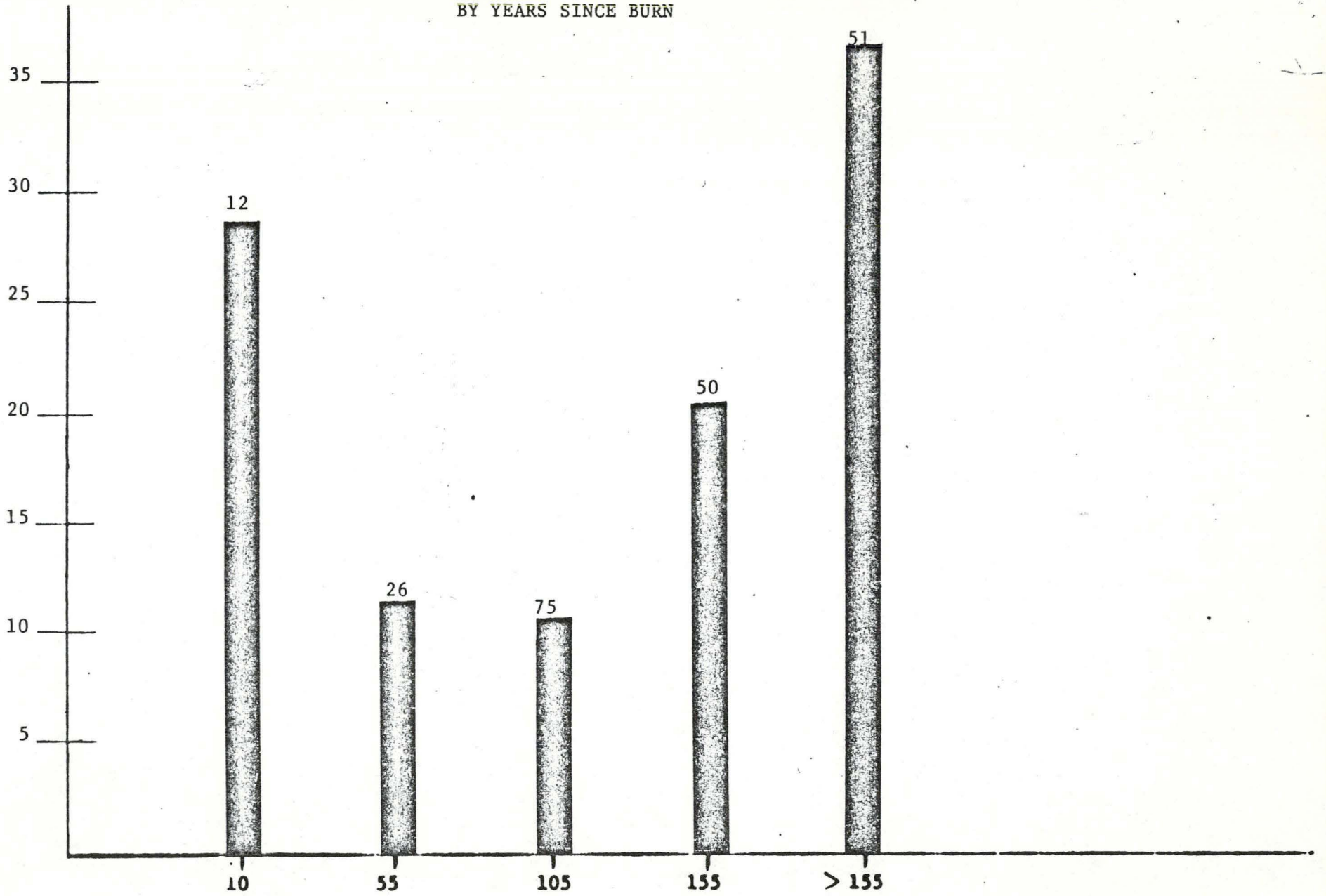
MEDIAN LOADING VALUES FOR FOREST TEN HOUR FUELS
BY YEARS SINCE BURN



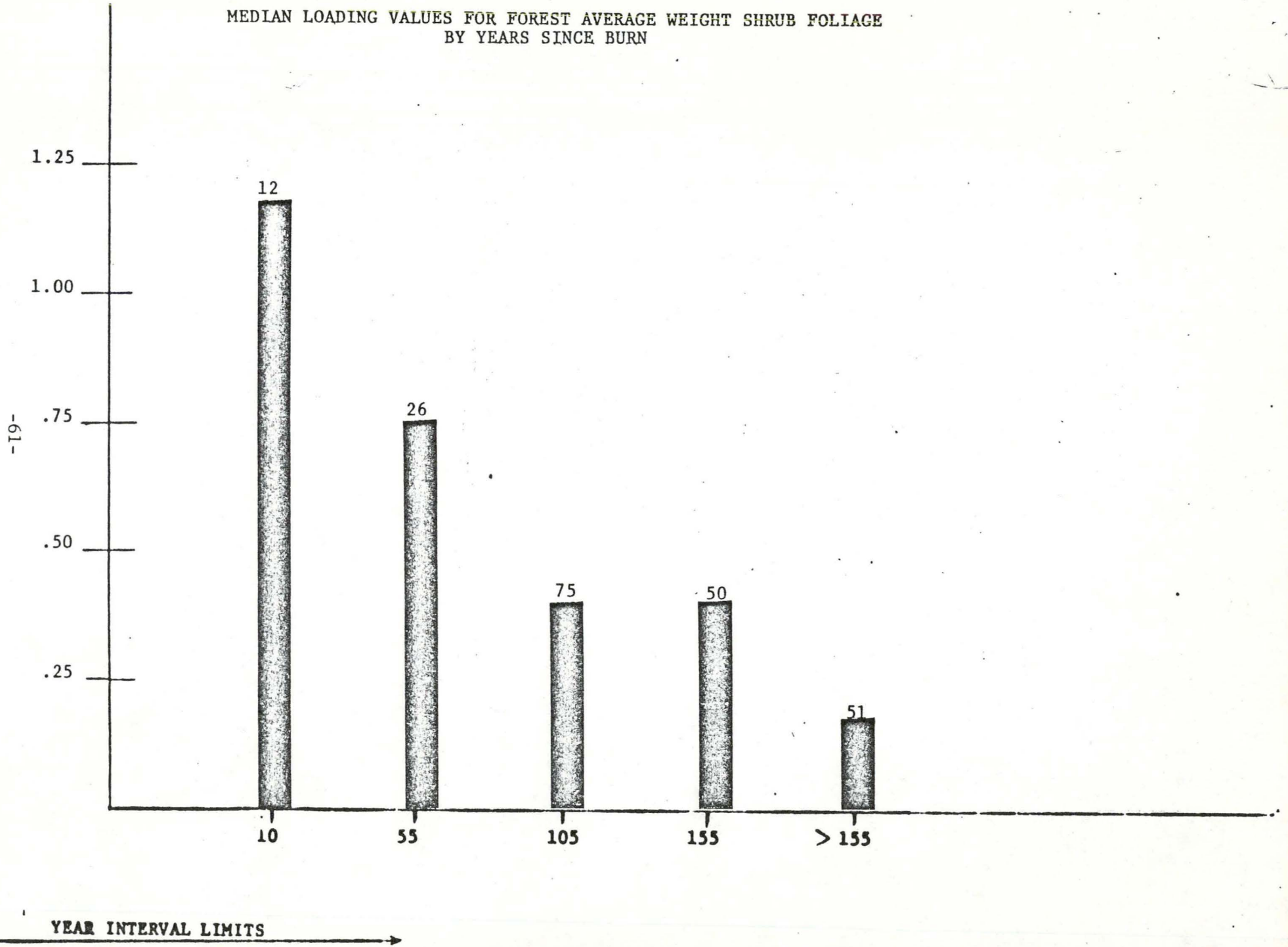
MEDIAN LOADING VALUES FOR FOREST ONE HUNDRED HOUR FUELS
BY YEARS SINCE BURN



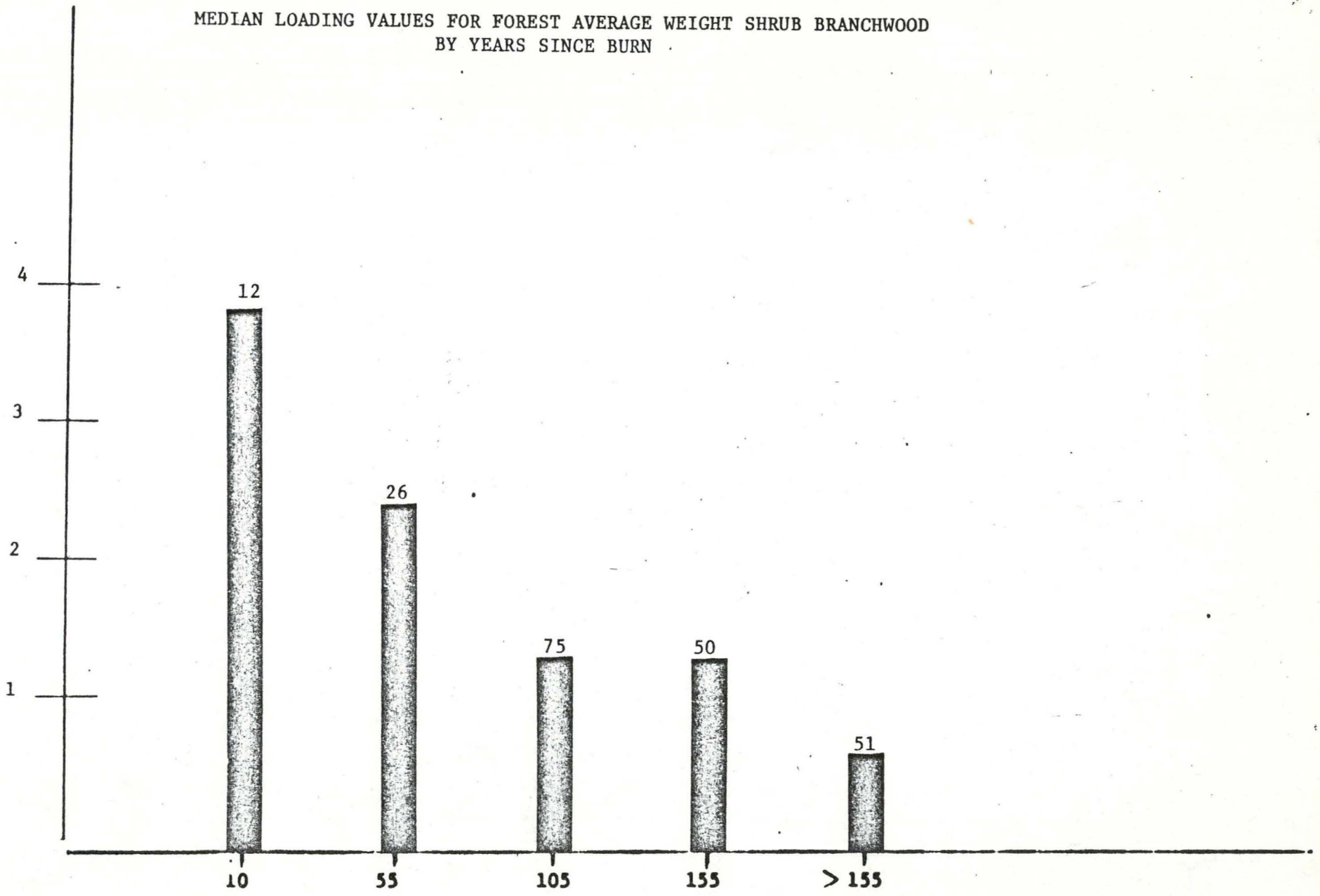
MEDIAN LOADING VALUES FOR FOREST ONE HUNDRED PLUS HOUR
BY YEARS SINCE BURN

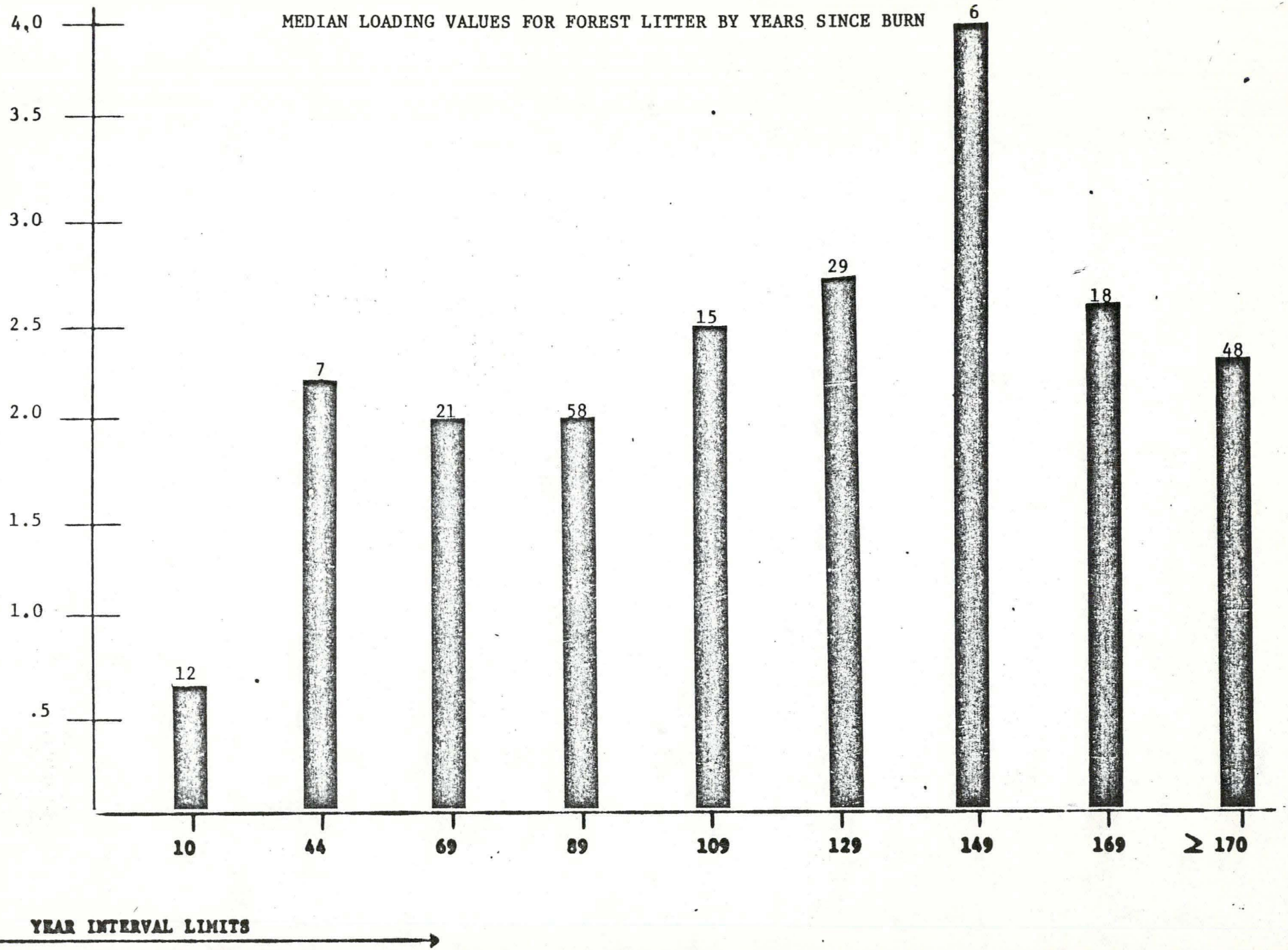


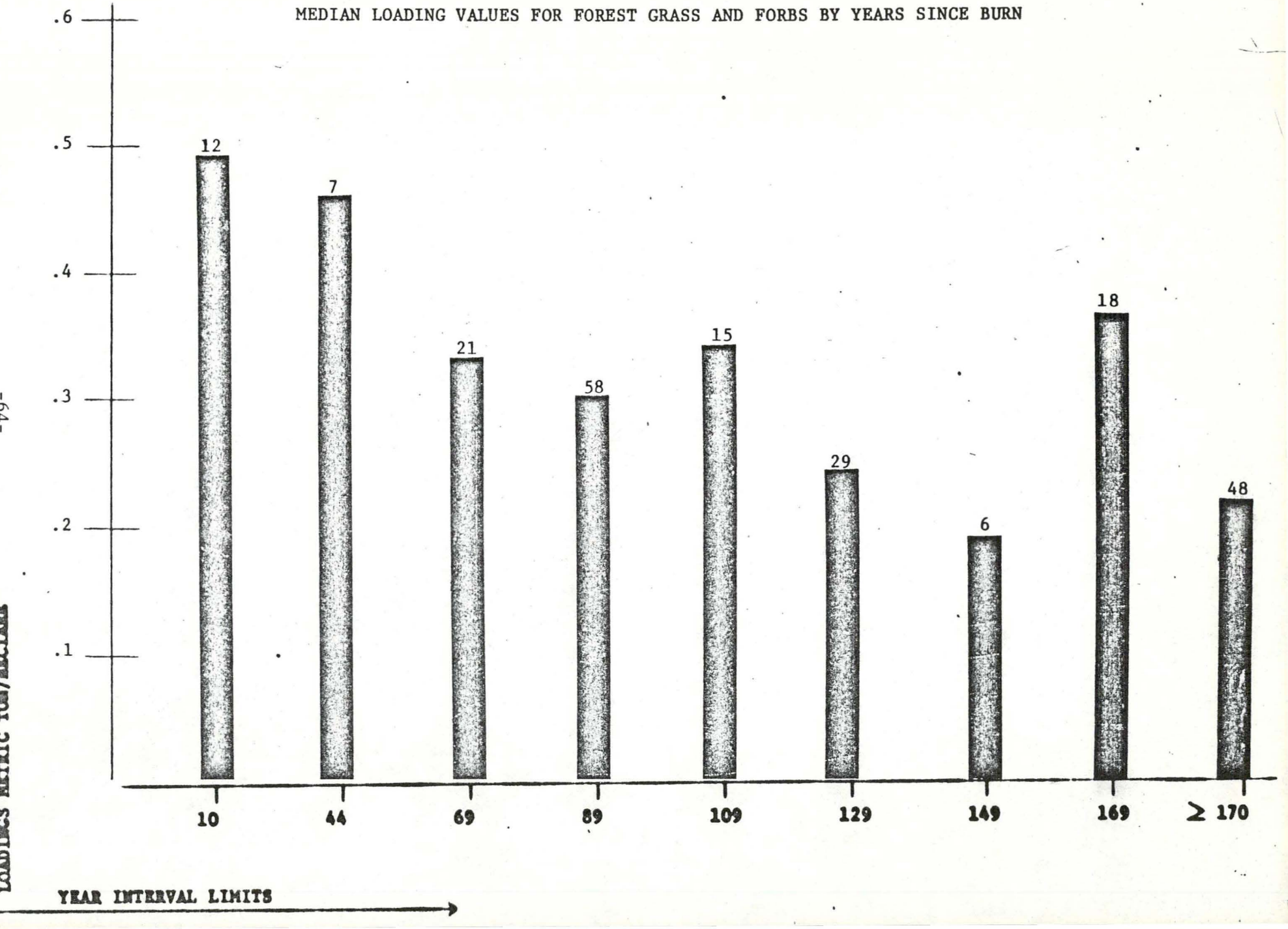
MEDIAN LOADING VALUES FOR FOREST AVERAGE WEIGHT SHRUB FOLIAGE
BY YEARS SINCE BURN

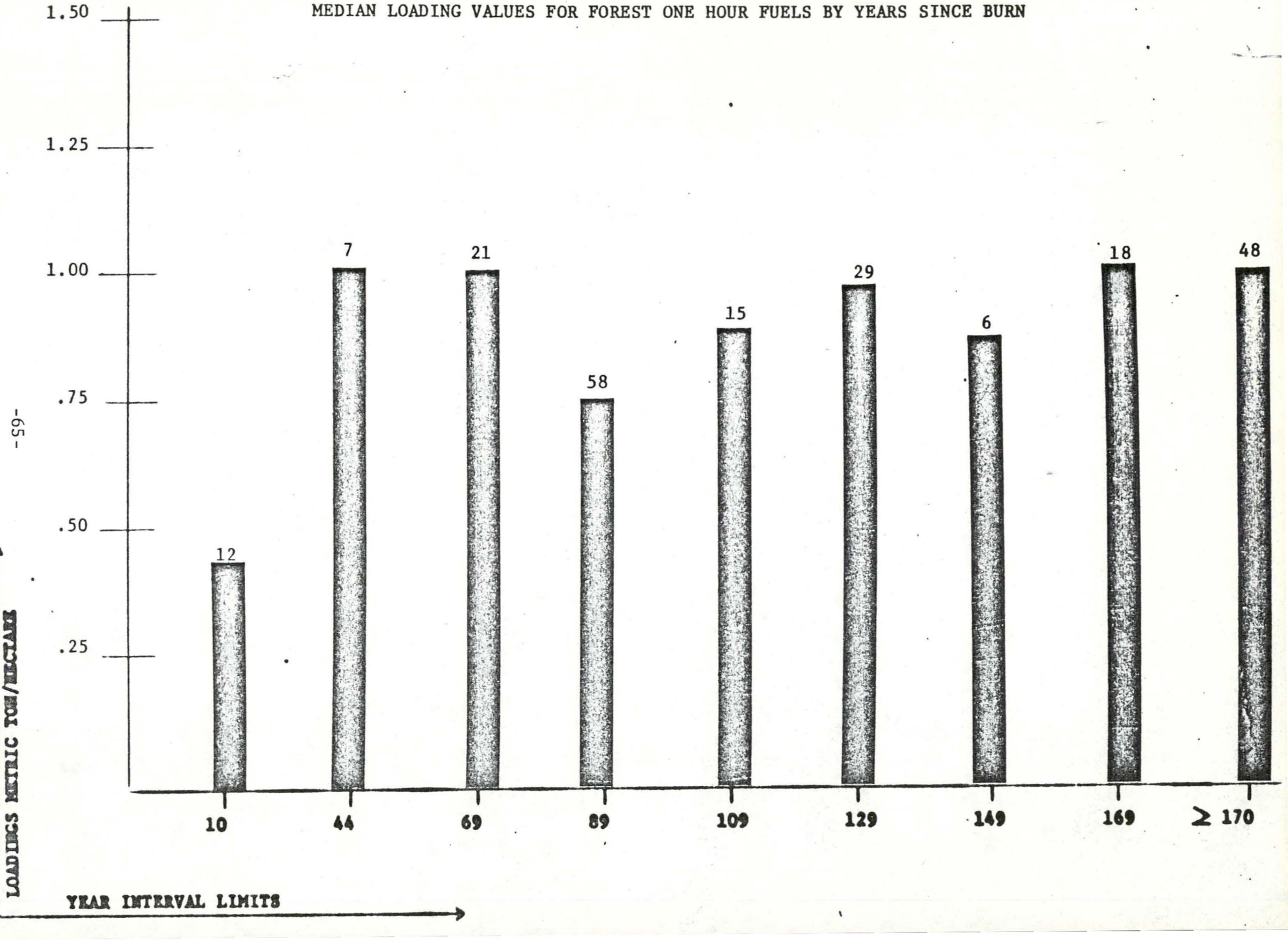


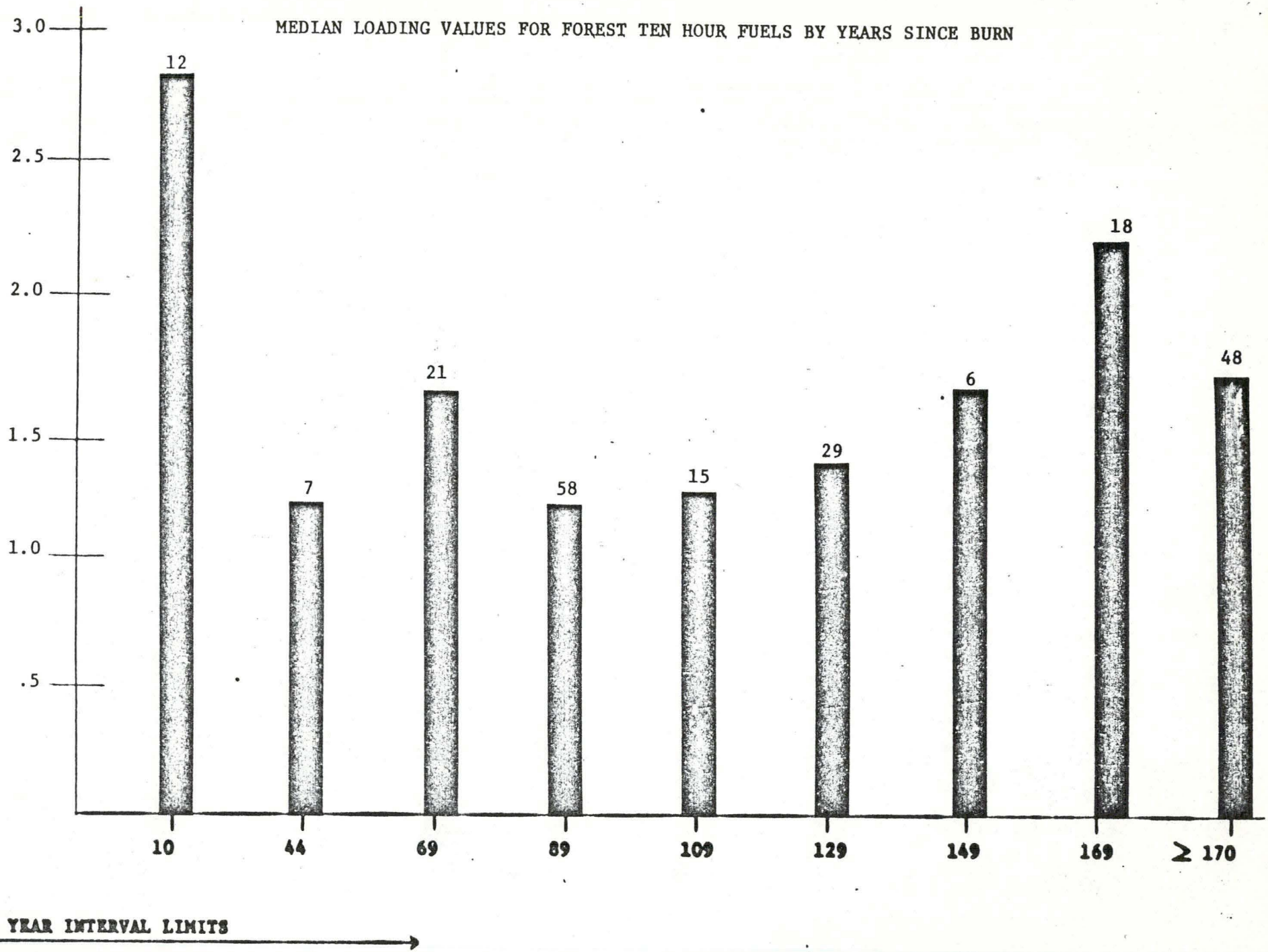
MEDIAN LOADING VALUES FOR FOREST AVERAGE WEIGHT SHRUB BRANCHWOOD
BY YEARS SINCE BURN



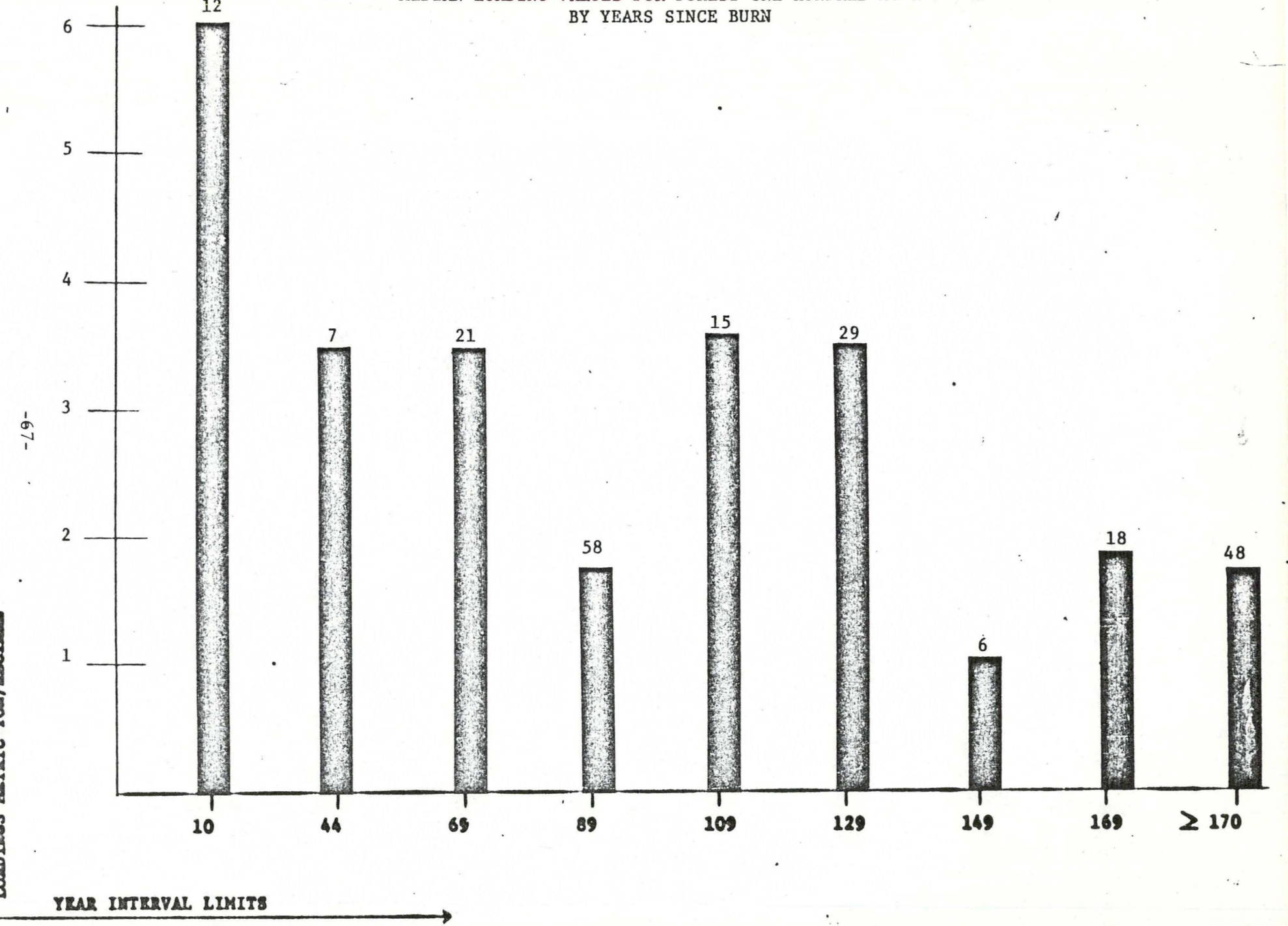

MEDIAN LOADING VALUES FOR FOREST LITTER BY YEARS SINCE BURN
4.0
3.5
3.0
2.5
2.0
1.5
1.0
.5
12
7
21
58
15
29
6
18
48
10
44
69
89
109
129
149
169
≥ 170
YEAR INTERVAL LIMITS


MEDIAN LOADING VALUES FOR FOREST GRASS AND FORBS BY YEARS SINCE BURN
.6
.5
.4
.3
.2
.1
12
7
21
58
15
29
6
18
48
10
44
69
89
109
129
149
169
≥ 170
YEAR INTERVAL LIMITS

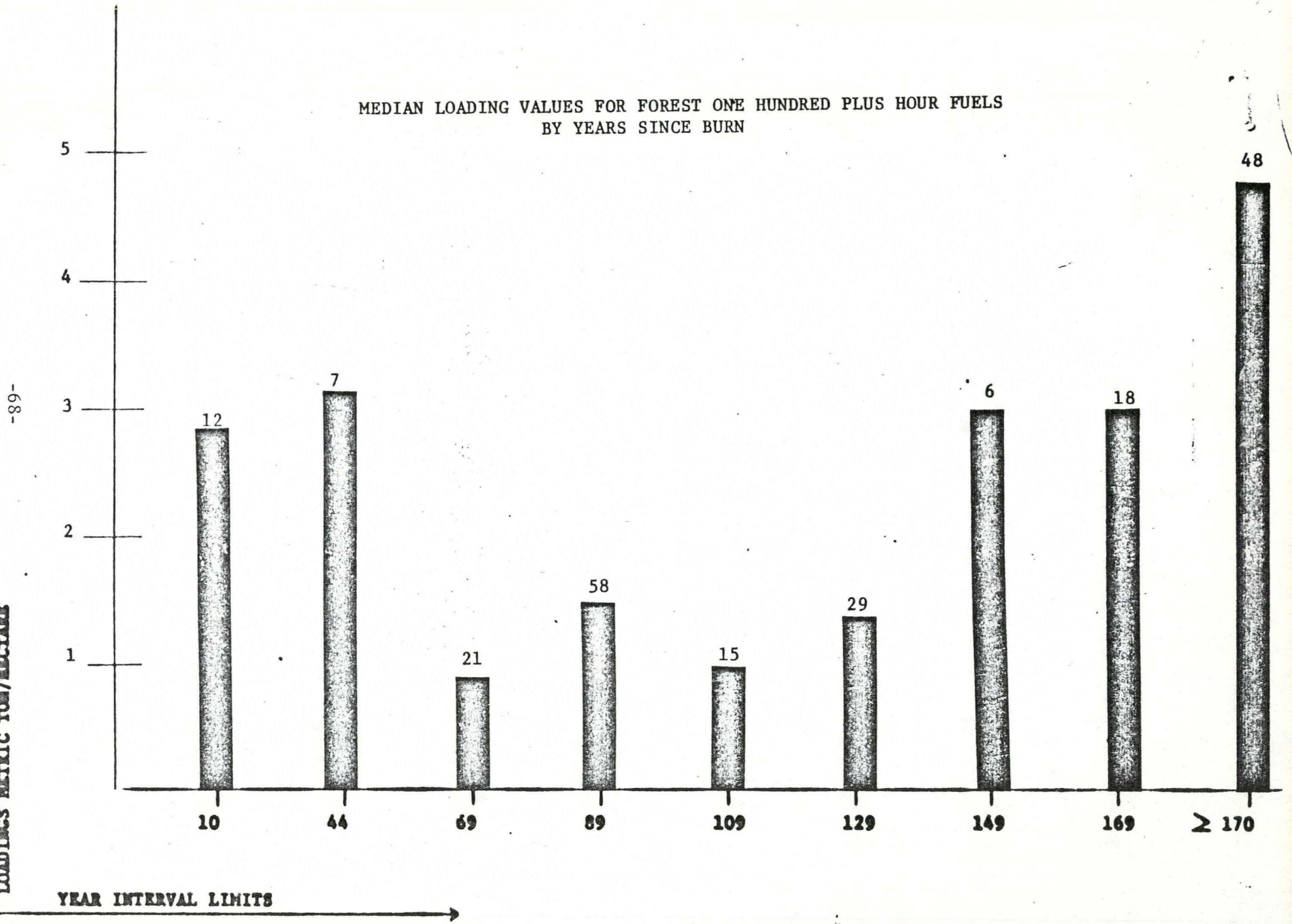

MEDIAN LOADING VALUES FOR FOREST ONE HOUR FUELS BY YEARS SINCE BURN
1.50
1.25
1.00
.75
.50
.25
12
7
21
58
15
29
6
18
48
10
44
69
89
109
129
149
169
≥ 170
LOADINGS METRIC TON/HECTARE
YEAR INTERVAL LIMITS

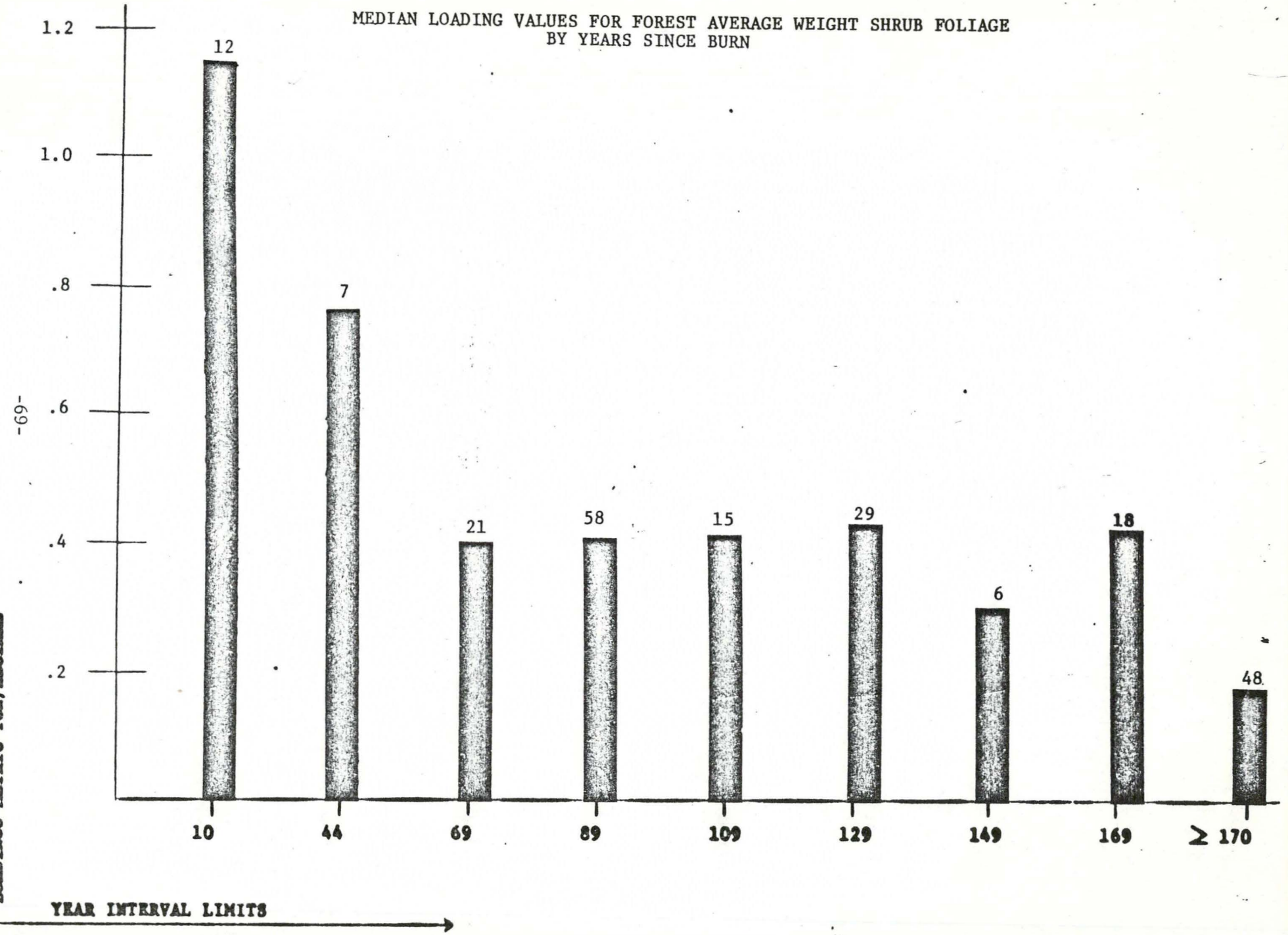

MEDIAN LOADING VALUES FOR FOREST TEN HOUR FUELS BY YEARS SINCE BURN
3.0
2.5
2.0
1.5
1.0
.5
12
7
21
58
15
29
6
18
48
10
44
69
89
109
129
149
169
≥ 170
YEAR INTERVAL LIMITS

MEDIAN LOADING VALUES FOR FOREST ONE HUNDRED HOUR FUELS
BY YEARS SINCE BURN

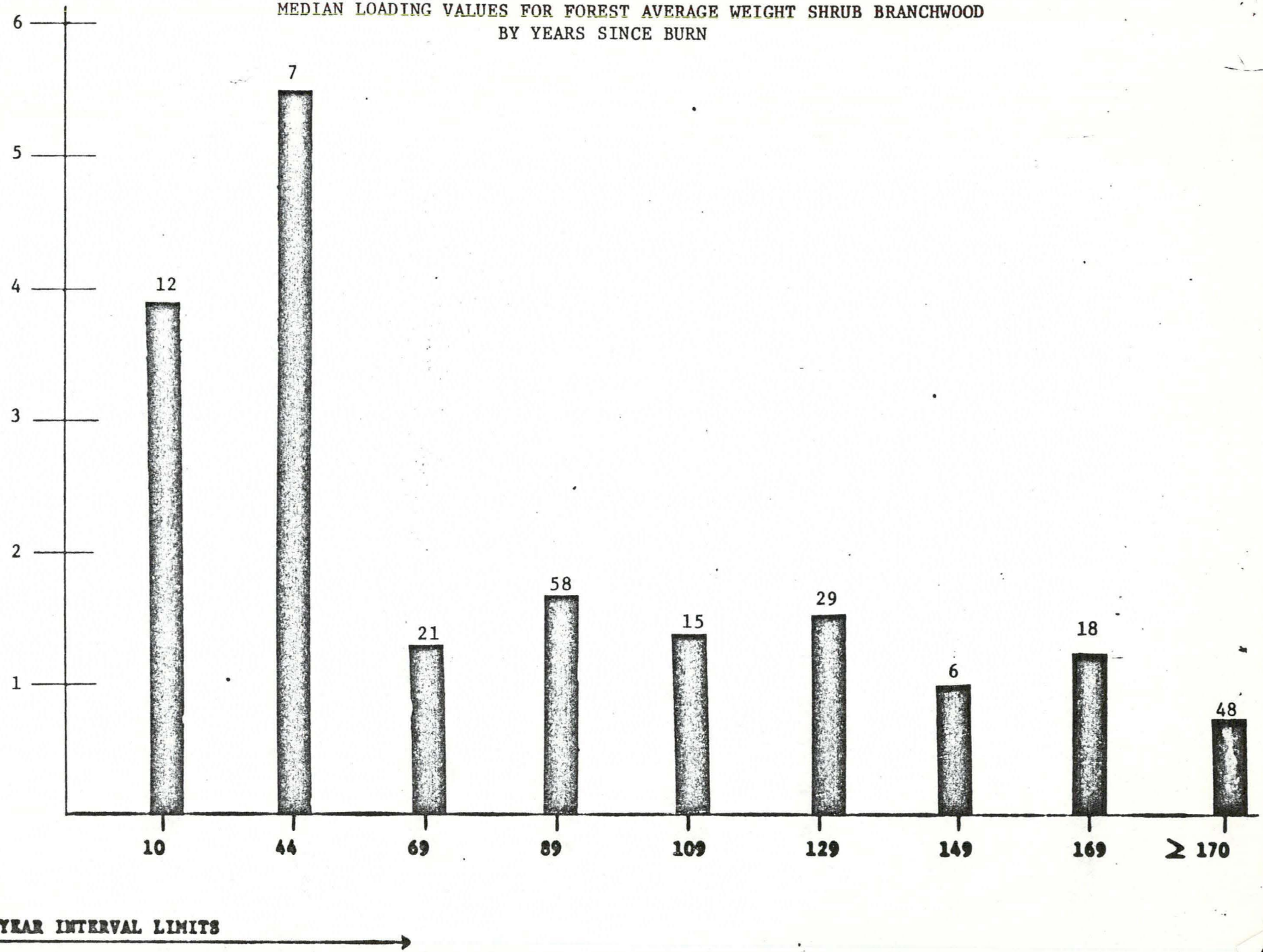


MEDIAN LOADING VALUES FOR FOREST ONE HUNDRED PLUS HOUR FUELS
BY YEARS SINCE BURN




MEDIAN LOADING VALUES FOR FOREST AVERAGE WEIGHT SHRUB FOLIAGE
BY YEARS SINCE BURN
1.2
1.0
.8
.6
.4
.2
12
7
21
58
15
29
6
18
48
10
44
69
89
109
129
149
169
≥ 170
YEAR INTERVAL LIMITS

MEDIAN LOADING VALUES FOR FOREST AVERAGE WEIGHT SHRUB BRANCHWOOD
BY YEARS SINCE BURN



APPENDIX C

SYSTEM CONTROL AND DOCUMENTATION

This appendix contains several sets of control card sequences and program formats necessary in the creation of the hazard evaluation system. They are included in this report for reference purposes only, and are not intended as instructions or guides in operating the system.

GENERAL FORMAT FOR ACCESSING ARCHIVED FIRE WEATHER DATA

OP stands for computer output. The computer singals ready for a new command by the symbol . All statemens start in first column.

YB= Year data begins
YE= Year data ends

If all years data is desired:

YB=00
YE=99

YYMMDD= date file is saved until

UMMSITE CODE
OP
>@RUN RUNID,ACCOUNT #,QUALIFIER(PROJECT)
>@ASG,AX FIREDATALIB*PROGRAMS.
>@XQT FIREDATALIB*LISTFILES
OP- Computer will now output station numbers and corresponding file numbers. Select the desired file number and give this file a name.
>@ASG,A FIREDATALIB*FILENUMBER
>@ASG,CP FILENAME.
>@USE 2.,FIREDATALIB*FILENUMBER
>@USE 15.,FILENAME.
>@XQT FIREDATALIB*PROGRAMS.GETDATA2
OP
> STATIDYB STATIDYE
>@EOF
OP
>@SAVE,D QUALIFIER*FILENAME.,YYMMDD
OP
>@SYM,UC QUALIFIER*FILENAME.,FCR002
>@FIN
OP
>@@TERM

ACTUAL RUNSTREAM FOR RETRIEVAL OF ARCHIVED FIRE WEATHER DATA

In this run:

PØLE is the run ID
GMI is the QUALIFIER
GMISHAW is the filename
21-26 is the filenumber
838 is the site code
* signifies computer output, > signifies ready for next command

```
UMM838
*UNIVAC 1100 OPERATING SYSTEM  VER. 32-R2-48      (RSI)*
>@RUN PØLE,1122314412LE,GMI
*DATE: 092176                  TIME: 13:19:00
>@ASG,AX FIREDATALIB*PROGRAMS.
>@XQT FIREDATALIB*PROGRAMS.LISTFILES


**                                STATION-YEAR LIMITS      DATE OF
FILE                              FROM       THROUGH     LAST UPDATE

FIREDATALIB*00-04                 00000000   04079999        011376
FIREDATALIB*04A                   04080000   04510599        011576
FIREDATALIB*04B                   04510600   04999999        012076
FIREDATALIB*05-09                 05000000   09999999        012176
FIREDATALIB*10-20                 10000000   20999999        012876
FIREDATALIB*21-26                 21000000   26999999        012976
FIREDATALIB*27-35                 27000000   35239999        012676
FIREDATALIB*35A-41                35240000   41999999        012776
FIREDATALIB*42-47                 42000000   47999999        012776
FIREDATALIB*48-50                 48000000   50999999        012776
FIREDATALIB*NEWYR                 00000000   99999999        091676
FIREDATALIB*FRCST                 00000000   99999999        091676

FIREDATALIB*FRCST75 00000000  99999999                       010976
(1975 FØRCAST DAT RETAINED ONLY UNTIL JAN. 31, 1977)
```

NØTE - THE TIME LAG IN THE RECØRDING ØF THE LIGHTING ACTIVITY LEVEL HAS BEEN REMØVED FRØM THE DATA IN THE REGULAR LIBRARY, BUT IS STILL PRESENT IN THE NEW DATA BEING CØLLECTED (NEWDAT). IT WILL BE REMØVED WHEN THAT DATA IS MERGED INTØ THE REGULAR LIBRARY.

MAR 3, 1976- THE FØLLØWING STATIØN-YEARS WERE LØST FRØM THE MAIN LIBRARY EARLIER IN 1976. THEY HAVE SINCE BEEN RECØVERED AND ARE STØRE ØN FIREDATALIB*NEWYR.

25240171
29200567
35310871
45170671
45210671
45220671

```
>@ASG,A FIREDATALIB*21-26
```

```
*READY
>@ASG,CP GMISHAW.
>@USE 2.,FIREDATALIB*21-26
*READY
>@USE 15.,GMISHAW.
*READY
>@XQT FIREDATALIB*PROGRAMS.GETDATA2

*FIREDATALIB SYSTEM NOTE 4/5/76- TO GET HISTORICAL DATA FROM THE
LIBRARY AND CURRENT DATA FROM THE NEW YEAR TAPE AS A SINGLE FILE,
GET SAMPLE RUNSTREAM BY @PRT,S FIREDATALIB*PROGRAMS.SINGLEFILE.


GETDATA2 NOW CONTINUES NORMAL PROCESSING

>  24021000  24021099
>  24020700  24020799
>@EOF

*DATA SELECTION 07/29/76

FROM      TO        REEL       OUTPUT

24020700  24020799  21-26      FORMATTED CARD IMAGES, N=  1287
24021000  24021099  21-26      FORMATTED CARD IMAGES, N=  1175

THERE ARE   2462 FORMATTED CARD IMAGES TOTAL ON THE FILE CREATED*

>@SAVE,D GMI*GMISHAW.,760809

*SV00  SAVE PROCESSOR    29 JUL 76    16:07:41   ENTER DESRIPTION*
> THIS INFORMATION IS FOR POLEBRIDGE AND WEST GLACIER
*SV88   SAVE REGISTERED SUCCESSFULLY.
        PURGE: 760809  DESC: THIS INFORMATION IS FOR POLEBRIDGE AND
         WEST GLACIER*
>@SYM,UC GMI*GMISHAW.,,FCR002
>@FIN

**RUNID: POLE           ACCT: 1122314412          PROJECT: GMI
      LOAD F09947 20/8 21-26 -1 POLE
SAVDGMI              GMISHAW      001     000076080911223144127607 29   07
SAV2 THIS INFORMATION IS FOR POLEBRIDGE AND WEST GLACIER
   TIME:    TOTAL:00:00:19:639
            CPU:  00:00:07:071        I/O:   00:00:05:115
            CC/ER:00:00:07:452        WAIT:  00:05:47:636
   IMAGES  READ:  13                  PAGES:   3
   START:   16:01:42 JUL 29,1976      FIN:   16:08:43 JUL 29,1976

SIZE: 017K

EST COST:  TOTAL:  00004.85
           CPU:    00002.80 I/O: 00001.35  CONNECT: 0000.70
TERMINAL INACTIVE*
>@@TERM
```

The Format of AFFIRMS Archived Fire Weather Data

Punch Card Format (Modified) for WS Form D-9a

Field Description	Begin Col. #	End Col. #
Station Number	1	6
Year	7	8
Month	9	10
Day	11	12
State of Weather		13
Dry-Bulb Temp. (°F)	14	16
Relative Humidity (%)	17	19
1-Hr-T/L Moist.	20	22
Herb-Veg-Cond (Model 1)	23	24
Man-Caused-Risk	25	27
Wind Direction (8 point)		28
Wind Speed (mph)	29	31
Woody-Veg-Cond (Model 1)		32
*10-Hr-T/L Moist. (%)	33	35
*100-Hr-T/L Moist. (%)	36	38
Max. Temp (°F)	39	41
Min. Temp (°F)	42	44
Max. R.H. (%)	45	47
Min. R.H. (%)	48	50
Not Used		51
Precip. Duration	52	53
Precip. Amount (in)	54	57
Lightning Act. Level	58	60
Digit "2"		61
Model 1 I.D.		62
Secondary Models:		
Model 2 I.D.		63
Model 2 Woody		64
Model 2 Herb	65	66
Model 3 I.D.		67
Model 3 Woody		68
Model 3 Herb	69	70
Model 4 I.D.		71
Model 4 Woody		72
Model 4 Herb	73	74
Model 5 I.D.		75
Model 5 Woody		76
Model 5 Herb	77	78
**Forecast Flag		79
Region Number		80

*See paragraph 6
**1 = Forecast; 0 or blank = Observation

Explanatory Notes for Modified WS D-9a Card Format

The card images are generated by the archiving processor of the "AFFIRMS" program. Some variations from the normal Weather Service WS D-9a form have been introduced. They are described below:

1) Because all humidity entries are converted by "AFFIRMS" to relative humidity (even though the input may have been wet-bulb, dewpoint, or R.H.) only the relative humidity is available for archiving. The presence of the digit "2" in card column 61 indicates that the data in columns 17-19 are relative humidity and not wet-bulb (standard for the WS-D9a).

2) The "AFFIRMS" system permits up to 5 fuel models to be associated with any given station. A separate woody-vegetation-condition and herbaceous-vegetation-condition can be specified for each model. Because later use of this data may require these conditions (for example, if live fuels are involved), the card format has been modified to include the first model's values in the normal positions on the card (23-25 for herbaceous, 23 for woody condition). The model identifier (a letter from A through I) for the first model is then placed in column 62. The other four models have their identification herbaceous-condition, and woody-condition placed in columns 63 through 78. Subsequent processing of these card images should check for a blank Model I.D. in column 62 indicating no model specification.

3) In the Max/Min temperature and humidity fields, a value of *100* in both Max and Min indicates that *both* values were missing. Subsequent processing should make this check.

4) The Forest Service Region number (column 79-80) is included for convenience in sorting by the National Fire Danger Rating Library before distribution to regional ADP offices.

5) The wind direction 8-point code in the card images has been derived from the sorted degrees-of-the-compass value. Some stations may enter wind direction in systems other than 8 point which offer more resolution, such as 16 point or degrees-of-the-compass. Such additional resolution is, of course, lost when this conversion to 8 point is made. Missing direction is recorded in the card images as "0".

6) The 1-, 10-, and 100-hour timelag fuel moistures are only archived if actually entered (non-missing) in an observation. In all cases where these items are computed from ambient conditions, they appear in the archived records as zero or blank.

7) For the period 1973 through March 1975, "AFFIRMS" made only one consistency check on the precip. amount: values were required to be between 0 and 10.00 inches. Occasionally, field personnel would enter 9 when they should have entered .90 or .09. These three values are all valid as far as the AFFIRMS program is concerned, therefore large precipitation amounts should be viewed with suspicion for this period.

Step 1. Dimension all arrays and initialize values.

Step 2. Read fuel moisture values (Tape 9), by TL class, sort each class into one percent fuel moisture intervals.

Step 3. Read wind and temperature data (Tape 7). Sort each by specified intervals, compile cumulative values, compute mean, standard deviation and standard error of both distributions.

Step 4. Cumulate values for each TL class's fuel moistures.

Step 5. Compute frequency distribution of temperature, and prepare data for plotting.

Step 6. Compute frequency distributions for wind and prepare data for plotting.

Step 7. Compute frequency distributions for each TL class fuel moisture.

Step 8. Print and plot all wind distribution values.

Step 9. Print and plot all temperature distribution values.

Step 10. Prepare fuel moisture distributions for plotting, compute mean, standard deviation, and standard error for each TL class. Print and plot all fuel moisture distribution values.

Step 11. Determine unique fuel moisture value (%) for the twenty, five percent intervals of cumulative moisture levels, for each TL class.

Step 12. Select plot (from Tape 5) in specified age group. Assign fuel moisture values (%) to each TL class. Call FIRE and compute scorch height for the plot under the assigned PARMS. Sort scorch height in one meter increments and store values in a counting array. Repeat call to FIRE until the plot has been evaluated at the twenty cumulative moisture levels, sorting and storing the twenty scorch heights in the counting array.

Step 13. Return to Step 12 until all plots of desired age have been evaluated, each at the twenty cumulative moisture levels.

Step 14. Compute cumulative frequency distributions of scorch heights for forest plots in the age class. Determine 25, 50, 75, and 100 percent cumulative levels of scorch height.

Step 15. Print cumulative levels as described earlier. Reset all arrays and counters used in this loop to zero.

Step 16. Rewind Tape 5.

Step 17. Age group specifications are changed and program returns to step 12. This loop continues until the four temporal distributions of plots have been evaluated.

Step 18. Stop.

CONTROL CARD SEQUENCE FOR EXECUTION OF FIRE HAZARD EVALUATION PROGRAM

```
 1.  Job Card; default time,75, core memory 100,000.
 2.  FETCHMT,WHOLE,00940.
 3.  COPY,WHOLE,1F,OLDPL.
 4.  REWIND,OLDPL.
 5.  UPDATE,F,L=O.
 6.  MNF,I=COMPILE.
 7.  RELEASE,WHOLE.
 8.  STAGE,TAPE7,11349.
 9.  LINK,X,CS=ZERO,PP=(,DUMMY).
10.  REWIND,TAPE7.
11.  REWIND,TAPE9,LGO.
12.  FETCHPS,GMI,FIRE,FIRE.
13.  FETCHPS,GMI,RANGE,RANGE.
14.  FETCHPS,GMI,PLOTM,PLOTM.
15.  COPY,INPUT,1RXR,PLOTM,1RXR,RANGE,1RXR,FIRE,CAROT/RR.
16.  MNF,I=CAROT,L=O.
17.  STAGE,TAPE5,11292,1F.
18.  LINK,X.
19.  EOR
20.  NINETEEN CHANGE CARDS.
21.  EOR
22.  FUEL MODEL DATA CARDS(eighteen)
23.  STATION DESCRIPTION CARD (lead card one) formatted as described in options
24.  LEAD CARD TWO
25.  LEAD CARD THREE
26.  LEAD CARD FOUR
27.  BLANK CARD
28.  EOR

     MAIN PROGRAM NOW FOLLOWS
```

Procedure for storing weather data (on cards) on to a tape at Berkeley. Tape assigned to this process was tape #11349.

```
STORE.803645,2108-BGMI BRADSHAW
REQUEST,TAPE,11349,W,B.
COPY,INPUT,1F,TAPE/RR.
EOR
DECK OF DATA CARDS
EOR
EOF
```